

The Philippine Agriculturist

VOL. X, NO. 10

MAY, 1922

THE MODERN CONCEPTION OF NUTRITION AND SOME OF OUR FOOD PROBLEMS¹

By MANUEL L. ROXAS
Of the Department of Chemistry

It may seem strange that I should be addressing a distinguished assembly of physicians and pharmacists when my interest lies in things pertaining to agriculture, but agriculture and the medical profession really have many things in common. We agriculturists raise foods so that people may be healthy, and you physicians cure people when we give them, either too much or too little, to eat.

I wish to speak about certain phases of the modern conception of nutrition and some of our food problems in the Philippines. The modern science of nutrition has discovered much about properties of foodstuffs, that you, as physicians, and we, as farmers, should take a great deal of interest in. Permit me to review for you, briefly, the phenomenal development of the modern science of nutrition.

HISTORICAL

As early as 1840, the relation between the chemical composition of the animal body and that of food was familiar to the chemist. It was even, then, common knowledge that the body of animals was mostly composed of four types of compounds: the carbohydrates, the fats, the proteins, and the mineral elements. It was also known that the food of animals contained, mostly, these same types of compounds. Carl Voit (1) wrote in 1881:

Unquestionably it would be best for the purpose (of food studies) if one could feed only pure chemical compounds (the pure foodstuffs), for example pure protein, fat, sugar, starch, ash constituents or mixtures of the same. However, inasmuch as men and also animals only rarely tolerate continuously such tasteless mixtures, it is necessary in most cases to choose foods as they are provided by nature. Nevertheless, it would probably be possible and very desirable to repeat with the pure substance the trials with the natural food products, although the results yielded thereby might not be essentially different.

But all attempts to feed animals these purified compounds resulted, sooner or later, in their failure to live. About 1905, Professor Hopkins (2) of Cambridge, England, attempted to maintain animals with purified protein, carbohydrates, fats, and mineral salts, but found that such food mixture was not

¹ This paper was to have been read at the Medico-Pharmaceutical Convention, in Manila, February 8. A delayed notification of date prevented the author from presenting it. A part of the paper was, however, read before the Philippine Association of Technical Agriculturists, in Manila, on February 12. Experiment Station contribution No. 85.

able to promote growth in the animals. In 1912, he tried adding small amounts of whole milk to such mixtures, and observed that growth could be secured. He concluded that there must be present in milk "unsuspected dietetic factors" which are essential in normal nutrition.

A number of human diseases the etiology of which was traceable to faulty diets has been known for many years. Scurvy was very common among sailors confined to a diet of biscuit and salted meat "in the days of the long sailing voyages." It was, even then, of common knowledge that the suffering from scurvy could be relieved with the use of fresh vegetables and fruit. Rickets was another disease that was traceable to deficient nutrition.

Among the oriental peoples, beri-beri is common. The relation of beri-beri to diet became better known when in 1897 Eijkman (3) induced polyneuritis in pigeons by feeding them polished rice. He subsequently effected a cure with rice polishings. Ten years afterwards, in 1907, Frazer and Stanton (4) showed that experimental polyneuritis can be cured with alcoholic extract of rice polishings.

In 1909, Stepp (5) observed that grown mice thrived well on bread made with milk, but when such bread was extracted with alcohol before feeding it to the animals, they invariably failed to grow. He also found that ether and chloroform did not remove the unknown substance in the bread.

Funk (6) took up the study of beri-beri in 1911 and attempted to isolate the curative substance in rice polishings proposing to call it vitamine. Funk's vitamine, or the anti-beri-beri is now supposed to be identical with McCollum's water soluble B.¹

When the great German chemist, Emil Fisher, discovered a method for the study of proteins and this method was applied by Kossel in Germany and Osborne in the United States to the study of proteins from different sources, it was found that the hydrolysis products from different proteins differed widely from each other. The products were practically all amino acids, and some eighteen of them have been isolated. It was found that certain proteins contained the 18 amino acids in greater or less proportion, while others lacked one or more. The discovery suggested that perhaps protein, after all, would have a different value in nutrition, contrary to the old belief. The discovery by Hopkins that there are unsuspected dietetic factors too subtle to detect by chemical means made chemists adopt the biological method in their study of the properties of food-stuffs. Osborne and Mendel, Hart, Babcock, McCollum, and others were among the American pioneers in this field. Credit for the discovery of the fat soluble A, another form of vitamine, belongs to McCollum (7) and to Osborne and Mendel (8), who worked independently of McCollum. How this discovery was made is worth recording here. In 1908, McCollum (7) fed rats with the following mixture:

Purified casein.....	18%
Lactose.....	20%
Starch.....	57%
Some form of Fat and Salt mixture.....	5%
	100%

¹ The work of Chamberlain and others on human beri-beri is already well known to the medical profession in the Philippines. It is simply an application of Eijkman's discovery.

Milk was considered a complete food, and in starting his several experiments, McCollum thought that it was desirable to use purified milk products. In these experiments he varied each factor in the mixture, one at a time. When he used fat from different sources, he made the important discovery that butter fat and egg yolk fats promoted growth, while lard, olive oil or other vegetable oils did not. Evidently, then, certain fats contain substances indispensable in the diet and which are not found in all fats. He even went so far as to extract this unknown substance with alcohol and re-dissolve it in inactive fats with successful results.

McCollum and his co-workers then undertook the study of the problem as to why animals cannot grow when restricted to a single grain, such as wheat, corn, oats, etc. These grains were shown by chemical analysis to be composed of carbohydrates, fats, proteins, and mineral salts. They thought that the grains may be deficient in their fat or in the unknown factor in food discovered in their first experiment, in protein or mineral salts or in any two or all of them. They then ran a series of experiments with wheat, supplementing it, first, with addition of one of the factors used in the diet referred to above and with which they obtained normal growth. Their first results run up as follows:

1. Wheat alone—no growth—short life.
2. Wheat plus purified protein—no growth—short life.
3. Wheat plus salt mixture—very little growth.
4. Wheat plus butter fat (containing the unknown substance they previously found to be essential constituent of food)—no growth.

These results were puzzling. "Well," they said, "let us try addition of two factors at a time." And they continued the series with the following results:

5. Wheat plus protein, plus salt mixture—good growth for a time—few or no young—short life.
6. Wheat plus protein, plus butter fat—no growth—short life.
7. Wheat plus salt mixture, plus butter fat—fair growth for a time—few or no young—short life.

The partial success obtained encouraged them to try addition of the three factors, with following results:

8. Wheat plus protein, plus salt mixture, plus butter fat—good growth—normal number of young, good success in rearing young—life approximately the normal span.

From the results they obtained with the purified food mixture, and the supplemented wheat they very naturally concluded that there was only one mysterious substance essential in normal nutrition, and that was contained in butter fat. This view, however, was not consistent with Funk's finding that butter fat was not effective in curing beri-beri. When McCollum applied the same method of investigation to the study of polished rice, he found that this grain product was not like wheat, in that it would not maintain animals successfully when supplemented with purified protein, butter fat, and properly constituted salt mixture. This mixture failed utterly to induce any growth in young rats; the animals in the course of a few weeks developed a condition suggestive of polyneuritis or beri-beri. There was an apparent contradiction between their results with wheat and those with polished rice. Polished rice, like wheat, is

nothing but a mixture of starch, fat, proteins, and mineral salts. The only difference between this diet and the purified food mixture they used in their first experiment was the 20 per cent of lactose. They decided to repeat their first experiment replacing the 20 per cent lactose with starch, and they found that the modified diet behaved exactly like the supplemented rice. They, therefore, concluded that lactose must either be necessary in the food or else it contained something in very minute quantities whose absence in the rice diet "made the difference between success and failure". The lactose they used was thought to be sufficiently pure, since chemical test indicated complete absence of nitrogen. However, to make sure they recrystallized it several times and repeated their experiment using the highly purified product. They then found that the purified food mixture with highly pure lactose was, like polished rice, utterly inadequate for the growth and maintenance of the animals. The conclusion was clear that the lactose they used contained a second mysterious substance essential in normal nutrition, and this could be removed by re-crystallization. Following the method of Frazer and Stanton, they then made alcoholic extracts of a number of foodstuffs and tested them for their contents of the second mysterious substance needed in nutrition. This substance is now supposed to be identical with Funk's vitamine, the absence of which in the diet caused beri-beri in man and polyneuritis in rats and fowls. McCollum and Kennedy (9) proposed to call these two mysterious substances, the one found in butter fat, fat soluble A, and the one contained in their lactose preparation, water soluble B. The word vitamine however, because perhaps of its simplicity, is more generally used.

The existence of a third vitamine, C, the antiscorbutic, has been demonstrated, also by the biological method, by a number of investigators, notable among whom are Hess, Cohen and Mendel (10). The needs of animals for the different dietetic factors vary to some extent according to their state of development (11). Vitamine B is required both by young and old animals, and the disturbances that its absence occasion in the animal manifest themselves in very short time. Apparently young animals have a greater demand, than the old for the fat soluble A. The disease that follows the lack of vitamine A in the diet does not ensue as rapidly as in the case of vitamine B. The first manifestation of the absence of vitamine A is cessation of growth. If the faulty diet is persisted, then the characteristic nutritional disturbances, eye trouble, collapse, will follow. Vitamine C seems to be needed in their food by certain species of animals, such as the guinea pig and man.

The rôle of suitably constituted proteins in diets has been elucidated by the work of Henriques and Hansen (12), Osborne and Mendel (13) and many others. Certain amino acids are now known to play a vital part in nutrition and the classical experiments of Osborne and Mendel with zein and gliadin, the first, lacking tryptophane and lysin and the second deficient in lysine, are too well known to require repetition here. Suffice it to say that a number of these amino acids are essential "building stones" that cannot apparently be made anew in the animal body and therefore need to be supplied in the diet, so that the value of any given protein is limited to the essential amino acid found in lowest quantity or entirely absent. The "unlike digestibility" of proteins from different sources (14) needs, also, to be considered carefully. The proteins of some legumes are

more resistant to enzymatic digestion than either animal or many other vegetable proteins. Here, may lie the objection to an excessive use in the diet of such beans as mungo and native soy bean. Bateman (15) has, also, demonstrated the tendency of native egg-white to be poorly utilized in the digestive tube. He states that the digestibility of this protein is greatly enhanced by cooking at 70° C. The question of digestibility is important since some of the proteins have "coefficients of digestibility" of less than 45 per cent.

THE MODERN CONCEPTION OF NUTRITION

It is now generally accepted that there are at least seven factors essential in normal nutrition: proteins, fats, carbohydrates, mineral constituents, and vitamins A, B, and C. The proteins must be so constituted that all essential amino acids would be supplied in proper amounts. The well-known law of the minimum holds in all cases. Recent researches have also shown that all naturally occurring foodstuffs are deficient in a number of these factors and that this is the reason why people have come to require variety in their food. It has, also, been demonstrated that vegetable proteins are not of the same value as animal proteins and that the proteins of animal origin possess the greater biological value. Since the food intake of animals depends largely on need for calories, the question of supplementary relationship between the different naturally occurring foodstuffs is one of the highest practical value, since a poorly constituted diet may not supply the optimum of each essential constituent.

DIET AND THE SO-CALLED DEFICIENCY DISEASES

It is now known that other diseases in addition to beri-beri and scurvy are traceable to deficiency in one or more of the essential factors in nutrition. I wish to enumerate some of these diseases since they must be of special interest to the medical profession. It is now definitely established that the absence of vitamin A is responsible for a form of nutritive collapse resembling certain cases of malnutrition in children. Its absence also causes pathological changes in the eye, an abnormality which was described by Freise, Goldschmidt and Frank (16) as keratomalacia in the following words:

At approximately the time of the decline in weight, perhaps in the third week, the first eye symptoms manifest themselves: shedding of the eyelashes without general loss of hair. This is followed in the third to the fourth week by a striking enophthalmus, and in the fifth or sixth week by a visible affection of the cornea; dryness rapidly ensuing turbidity, and ulcerating decomposition without any marked inflammatory appearances. The two eyes of the same animal are frequently attacked with unlike severity; the ulceration invariably sets in, however, unless the animals previously succumb. Spontaneous healing or improvement never occurs.

Another disease caused by the absence in the diet of fat soluble A is the formation of urinary calculi. Osborne and Mendel (11), in 857 necropsies of experimental animals, found 81 cases of urinary calculi consisting of calcium phosphate. They report the following:

Thirty-five (43 per cent) of the rats had never received butter fat or any other source of the fat-soluble vitamin in their rations. Of the remaining forty-six cases, none of the animals had received food known to furnish such a vitamin during the entire course of the experiment; and only thirteen had this substance during more than one half of the period in which they were on an experimental diet. . . . In other words, in every instance where calculi developed, the animals were without an adequate source of the fat-soluble vitamin for some time.

It is also suspected that the fat soluble vitamine or some substance associated with it acts as antirachitic. "Rickets is another disease related to the absence of fat soluble A."(?) The relation between cod liver oil¹ and calcium retention in the body has been demonstrated by the researches of McCollum, Hart (24) and others.

The relation between vitamine B and beri-beri is now generally accepted.

Pellagra (7), a disease common among the Italians and among people in the southern United States, has been traced to poorly constituted diet, mostly due to low animal protein intake. Vitamine C is a preventive of scurvy (10).

The relation between appetite and the vitamine content of foods is of the highest significance. Mendel (14) states in this connection:

We have frequently observed that one of the conspicuous manifestations of a dietary regimen deficient in certain types of vitamine is a diminished food intake. The feeding of vitamine-containing products almost always results in an improved appetite, if one may judge this by the resulting ingestion of increased amounts of the same ration which was refused on the vitamine free-regimen. . . . And in another paper: Those whose appetites are poor get less vitamine than those who eat well, hence the former may be in danger of falling into a vicious circle, because appetite to a large extent depends on the proportion of water soluble vitamine in the diet.

It is to be noted that none of the vitamins have been isolated and that so far we only know that they exist because of their effect.

DISTRIBUTION OF THE VITAMINES IN NATURAL FOODSTUFFS AND THEIR THERMOSTABILITY

Because of the relation between food supply and the frequent occurrence of the deficiency diseases among our people, it is important to know the distribution of these "accessory factors of the diet" in our natural foodstuffs. Numerous researches by investigators, mostly in America (17) have disclosed the fact that the fat soluble A is abundant in milk, eggs, leaves of plants, and vegetables like tomatoes, sweet potatoes, and carrots, where it seems to be associated with the yellow pigment. It has also been shown that this vitamine is not destroyed by the ordinary method of cooking; but it is easily destroyed by prolonged heating and aeration (18). The fat soluble A is also found in liver, the endocrine glands and in beef fat but not in lard. The water soluble B is more widely distributed in plants than the fat soluble A, and the fact that some people in the orient suffer from lack of this vitamine is indication that they live too exclusively on rice. The vitamine is found in large quantities in tomatoes, leaves of plants, tubers, and vegetables in general, in moderate amounts in milk; is practically absent in polished rice but present in unpolished rice.

Vitamine C is found in fresh vegetables. Sherman (19) summarizes our knowledge of the distribution and thermostability of this vitamine in the following words:

Raw cabbage, dandelion greens, lettuce, endive, sorrel, potatoes, carrots, bananas, apples, and cloudberry all showed anti-scorbutic properties—apparently in varying degrees. Apples and bananas were thought to be somewhat less effective than the potatoes, lettuce, greens and berries. Cabbage and dandelion juices seem to lose their antiscorbutic properties more rapidly than the vegetables themselves. Fruit juices and sorrel juice on the other hand retain their efficacy as antiscorbutics remarkably well. Raspberry juice

¹ In a recent article appearing after this paper has gone to press, McCollum and his co-workers published data to show the existence of a substance different from Fat Soluble A. in Cod liver oil which seems to have a sparing action in calcium metabolism. See *Journal Biol. Chem.* 50, 5-30, 1922.

seemed but little injured by heating for 1 hour at 100° or oven 110°. Acidulated cabbage or dandelion juice retained its antiscorbutic property much better than the natural juice of these vegetables. If, as these experiments indicate, the antiscorbutic property is due to the presence of some unstable substance, the latter would appear to be much more stable in an acid than in a neutral or alkaline medium.

The effect of cooking was studied in the case of several different foods with the following results: Cabbage cooked at 100° for ½ to 1 hour was still a good antiscorbutic. Carrots cooked at 100° for 1 hour showed a great diminution in antiscorbutic power. Cooking for ½ hour at the same temperature showed a less serious injury to the antiscorbutic property. Cauliflower was much injured by cooking for 1 hour at 100°; when cooked only ½ hour it was a much better antiscorbutic. Dandelion leaves lost much of their antiscorbutic property when cooked for 1 hour at 100°. Potatoes cooked at 100° "in the usual way" (½ hour) had excellent antiscorbutic properties. Turnips and kohlrabi cooked at 100° had antiscorbutic power similar to cooked potatoes. Cloudberry retained their efficiency after cooling to a very marked degree. When cooked at 100° as usual they were still excellent antiscorbutics and were shown to retain this property when kept for at least 3 months after cooking. From this it would appear that canned fruit which has been sterilized at temperature of boiling water and then kept in a cool place ought to be a good antiscorbutic even after many months, and in general that ordinary cooking of vegetables (or low temperature pasteurization of milk) destroys only a part of the antiscorbutic substance, and so the food still possesses antiscorbutic properties though not in as high degree as when raw.

A much more complete summary of our knowledge of vitamins is given in the report of the Lister Institute and the Medical Research Committee on *The Present State of Knowledge Concerning Accessory Food Factors* (26).¹

THE DIET OF THE FILIPINO

Many writers have stated that the average Filipino is undernourished and this seems to be borne out by the frequency of cases of beri-beri and the appalling infant mortality in the Islands. Doctor Concepción (20) in a paper read before a gathering of this distinguished assembly in February, 1918, said:

Under circumstances like these (referring to the poor condition of the people who were unable to meet the cost of more nutritious food with their limited income) infant mortality cannot be considered other than compensatory and if more of those young lives are to be saved and preserved to manhood it will not be solely as a result of improved sanitary conditions, but as a result of marked improvement in the present economic situation.

This statement points out the importance of more dietary studies in the Philippines in order to better determine the most economical and desirable way of improving the Filipino diet.

The basis of our diet is rice. In the studies of Aron and Hocson (25) and of Concepción (20) it was found that rice constitutes from 80 to 90 per cent of the Filipino diet. It was also found that the diet of the subjects of these studies was very one-sided and mostly poor in protein. Their studies were made among the urban population.

We have thought that perhaps the nutrition of the farmers would show a better plane of intake both as to quality and quantity. Our studies of three typical peasant families near the college farm shows them not much better fed than the urban population. These studies were for a period of one year,

¹ A Table on "Distribution of Vitamins in Investigated Food materials" published in Sherman's "The Vitamins," a copy of which has been received after this paper has gone to press (*The Vitamins*, by H. C. Sherman and S. L. Smith, pp. 273, New York, 1922.) will be reprinted in the next number of *The Philippine Agriculturist*.

observation being made once a week for one whole day. A summary of our results is given together with the tabulated descriptions of the families:¹

TABLE I.—*Giving the families studied.*

Family.	Members of the family.	Age.	Weights Dec. 1917.	Weights Oct. 1918.	Occupation.	State of health.	Wages.
I			kg.	kg.			Pesos
	Man.....	36	48.0	49.0	Common laborer working 9 hours a day.....	fair	0.80 day
	Woman....	33	45.8	46.0	Laundry woman.....	fair	10.00 month
	Boy.....	22	54.0	52.0	Student, Col. of Agri...	good	10.00 month
	Boy.....	17	38.0	42.0	Laborer.....	fair	8.00 month
	Boy.....	16	33.6	35.2	Laborer.....	good	6.40 month
	Girl.....	12	29.0	33.0	Attending public school.	good	
	Boy.....	10	26.0	26.8	Taking care of a carabao	good	
	Boy.....	5	14.1	16.0		fair	
	Boy.....	3	13.5	14.4		fair	
II							
	Couple ^a						
	Man.....	46	54.2	56.8	Laborer.....	good	
	Woman...	40	50.0	44.2	Housekeeper and nursing baby.....	fair	
	Couple ^a						
	Man.....	27	44.0	45.4	Boiler-tender.....	good	1.20 day
	Woman...	16	48.0	40.6	Housekeeper.....	pregnant	
	Man.....	25	47.8	48.0	Student janitor at College of Agriculture.....	good	18.00 month
	Woman....	17	41.8	40.6	Housekeeper.....	fair	
	Boy.....	4	14.4	14.4		good	
III							
	Man.....	25	47.8	48.0	Janitor at the Col. of Agri.	good	18.00 month
	Woman....	17	41.8	41.8	Housekeeper.....	good	

^a A baby was born to the couple during the experiment.

¹ The data presented in these tables were collected and tabulated, largely, by Mr. Esteban Collado, assistant in the Chemistry Department. The author makes grateful acknowledgment for the use of these tables and also for assistance in making the extensive calculations incident to the applications of the tables in this paper.

TABLE II.—Plane of intake of three Los Baños families.

Foodstuffs	Family I.					Family II.					Family III.				
	Weight.	Protein.	Calories.	Calcium.	Cost.	Weight.	Protein.	Calories.	Calcium.	Cost.	Weight.	Protein.	Calories.	Calcium.	Cost.
	gm.	gm.		gm.	c.	gm.	gm.		gm.	c.	gm.	gm.		gm.	c.
Meat and fish.	113.6	20.8	130.2	0.03		185.9	34.10	236.1	0.043		115.9	26.7	193.7	0.052	
Eggs.....	0.7	0.1	1.3	0.0004		1.8	0.23	3.4	0.001		4.2	0.6	7.9	0.003	
Milk.....	—	—	—	—		—	—	—	—		—	—	—	—	
Grain products.	582.1	45.6	2023.5	0.053		507.6	37.54	1761.9	0.047		443.9	34.7	1534.8	0.040	
Vegetables.....	110.4	3.4	149.3	0.028		103.8	3.16	87.4	0.041		168.2	4.1	86.5	0.054	
Sugar.....	10.6	—	42.4	—		2.7	—	10.8	—		5.9	—	23.6	—	
Miscellaneous..	—	—	—	—		—	—	—	—		—	—	—	—	
TOTAL.....	817.4	69.9	2346.7	0.1014	16	801.8	75.00	2099.6	0.132	22	738.1	66.1	1846.5	0.149	21
Average for three families.....															

NOTES:

Rice solids per cent, total solids..... 87. 84. 84.

Protein per cent, total solids..... 12.1 14.6 14.7

Cost per M calories, centavos..... 6.82 10.45 11.38

NOTES:

Rice solids per cent, total solids

Protein per cent, total solids...

Cost per M calories, centavos.....

TABLE III.—*Each type of foodstuff in percentage of total, for the three Los Baños families.*

Families.	Foodstuffs.	By weight.	Calories.	Protein.	Animal protein. Total.
I		<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
	Meat and fish.....	13.89	5.55	29.45	29.49
	Eggs.....	0.08	0.05	0.04	
	Grain products.....	71.22	86.23	64.20	
	Vegetables.....	13.52	6.37	6.31	
	Sugar.....	1.29	1.80	—	
II					
	Meat and fish.....	23.18	11.24	45.56	45.76
	Eggs.....	0.22	0.16	0.30	
	Grain products.....	63.33	83.92	50.04	
	Vegetables.....	12.93	4.16	4.20	
	Sugar.....	0.34	.52	—	
III					
	Meat and fish.....	15.71	40.39	10.48	10.91
	Eggs.....	0.57	0.91	0.43	
	Grain products.....	60.14	52.49	83.12	
	Vegetables.....	22.79	6.21	4.68	
	Sugar.....	0.79	1.30	—	

In these studies we endeavored to find the quantitative relationship between rice and the supplementary foodstuffs. In calculating our results, men at moderately active work were given the value of 1, women 0.8, children of different ages from 0.3 to 0.8. All figures given in the tables are in terms of man, per day.

Data on the dietary studies of a better class of Filipinos are given in Table IV. At the student mess of the College of Agriculture with an average of 90 boarders, we have followed the net food intake of the students for about three years. A summary of our results from June, 1919, to March, 1920, is given in Table IV.

TABLE IV.—Plane of nutrition of students eating at the student mess, College of Agriculture, June 1919 to March 1920

Average daily food of each student.											
Foodstuffs.	Total solids.	Carbo-hydrates.	Fat.	Ash.	Protein.	Vita-mines.	% of solid of vitaminic curriers in terms of total solids.	% of animal protein in terms of total protein.	Sold in rice — % total solid in food	Total calories.	Average cost.
	gm.	gm.	gm.	gm.	gm.		per cent	per cent	per cent		c.
Sugar.....	26.0	26.0	4.10	4.6	36.1				62.50	104.00	
Rice.....	400.1	355.2	1.25	1.9	4.5				62.50	1602.10	
Fish.....	9.2		25.98	1.2	16.1			5.8		29.25	
Meat.....	45.5		1.5	3.5	8.9			20.6		298.22	
Vegetables.....	71.4	53.8	2.2	0.2	1.8	+	11.10			267.90	
Eggs.....	4.2	0.4	2.2	0.6	5.6	+	0.65	2.3		28.60	
Bread.....	48.2	41.2	0.9	0.6	2.4	+				195.30	
Corn.....	24.1	20.1	0.5	0.6	0.6	+	3.76			94.50	
Milk.....	1.6	1.3	0.03	0.5	0.2					6.27	
Miscellaneous.....	1.3	1.0	0.07	0.03	0.2					5.43	
Solanum.....	4.5	3.7	0.10	0.2	0.6					18.10	
Cocoa, milk.....	5.0	2.9	1.2	0.8	0.8					25.60	
TOTAL.....	641.1	505.6	37.83	13.93	78.1		15.51	28.7	62.50	2,675.27	38

In Table V we also give the results of a more recent study, with still better diet, together with the relative cost of each type of foodstuff in percentage of the total.

TABLE V.—*Each type of food in percentage of total given to the subjects. (College of Agriculture. (Figures are from more recent studies 1921.)*

Average.					
Kind of foodstuffs.	Weight.	Cost.	Calories.	Protein.	Animal protein Total.
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Meat and fish.....	11.23	31.30	11.35	25.21	40.88
Eggs.....	3.09	9.04	2.22	4.97	
Milk.....	0.75	2.41	0.78	1.74	
Butter.....	0.15	1.56	0.50	—	
Grain products.....	61.10	31.81	75.16	57.10	
Vegetables.....	21.81	20.67	7.06	11.46	
Sugar.....	1.62	1.16	2.40	—	
Miscellaneous.....	0.25	2.05	0.53	0.86	

Notes:

Grams protein per person, per day...	\$5.5
Calories per person, per day.....	2817.4
Cost per person.....	38.1 pesos.
Cost per 1000 calories.....	13.5 pesos.

It is interesting to compare the plane of nutrition of our subjects with the dietary standards in other countries. From Langworthy's comparison of standards in different countries we take the following:

TABLE V.—*Comparison of dietary standards in different countries. Langworthy's comparison, reduced to 50 kilos body weight.*

Country.		Protein.	Calories.
U. S. A.	Farmers.....	71.5	2446.5
Canada	Laborers.....	71.2	2455.5
Japan	Laborers.....	87.2	2196
China	Laborers.....	91.0	3480
Egypt	Laborers.....	112.0	2825
Congo	Native.....	108.0	2817
Philippines	(Present studies) Farmers.....	70.4	2247
	Student mess.....	78.1	2673

The comparison of these standards shows that the Los Baños families eat less protein than the Chinese, the Egyptians, or the Canadians. The diet at the student mess compares favorably with these. It is possible that one reason for the low plane of nutrition of the Los Baños families may be lack of desire for greater quantity of their vitamin-poor diet. Osbourne and Mendel have

demonstrated in their work that while food intake is largely dependent on the calorific requirements of the body, appetite is dependent on the amount of vitamine B in the diet. They further state that there is a great deal of danger in this, since individuals may fall in a vicious circle. Our results at Los Baños show that this may be the case with the families studied, since vegetables and eggs, the vitamine carriers, constitute only 4.1 per cent of their diet. We have frequently observed at the student mess that the intake of rice maintains a certain proportion to the meat and vegetables given.

In our work we also figured out the amount of calcium in the diet. The standard for calcium given by Sherman is 0.67 grams per man per day. The amount found in the diet of the people studied by us is from 0.11 to 0.15. The students at the mess are no better off in this respect. These figures are much below the standard given. Our finding is in agreement with McCollum's statement that this element, as well as Na and Cl, is likely to be deficient in grains since over 80 per cent of the diet are grain products. He states that young animals lacking calcium in their food show poor growth. It is thus that calcium would be a limiting factor in the Filipino diet unless the bright tropical sun light enables people in the tropics to get along with very low calcium intake. (See series of articles by McCollum and co-workers appearing in current numbers of the *Journal Biological Chemistry*.) While the deficiency in Na and Cl is corrected by the salt added in the diet, the Ca intake is increased by a greater amount of vegetables and milk. Milk, alone, which supplies 9 per cent of the calories of the American food, furnishes 50 per cent of the calcium, while the vegetables constituting 9 per cent of the calories furnish only 13 per cent of Ca. (19)¹

Sherman (19) in his book, *The Chemistry of Food and Nutrition*, states that even the "ordinary mixed diet of Americans and Europeans, at least among dwellers in cities and towns, is probably more often deficient in calcium than in any other chemical element."

The effect of lack of calcium on individuals, and the need for it by healthy women must be already familiar to you. Sherman further states:

The calcium requirements of women are greatly increased by maternity. The need of an abundance of calcium for the rapidly growing skeleton of an infant is obvious. Before birth, and normally for several months after, this demand of the child is satisfied through the mother, whose calcium requirement is thus greatly increased. The weakening of the bones and teeth which is said to be a common accompaniment of pregnancy and lactation is held by Bunge to be largely due to a withdrawal of calcium from these structures to meet the nutritive requirements of the embryo or the nursing.

Lusk also emphasizes the importance of a diet rich in calcium for pregnant women, especially during the last ten weeks of pregnancy, when the fetus is storing calcium at a

¹ The proportions of the three important inorganic elements furnished by an average American dietary in per cent are as follows:

	Calcium	Phosphorus	Iron
Meats and Fish.....	3.68	26.70	31.43
Milk.....	50.19	18.52	4.72
Grain Products.....	15.31	28.85	24.95
Vegetables.....	13.25	14.65	26.22
All others.....	17.60	11.28	12.68
Energy.....	2928 calories		
Protein.....	101 grams		
Calcium.....	0.72 gram (0.36 gram from milk)		
Phosphorus.....	1.52 (3.48 P ₂ P ₅) (0.10 vegetable)		
Iron.....	0.0166		

rapid rate. He cites the data of Hoffstrom, who computed in considerable detail the demands of the fetus upon the mother for nitrogen, phosphorus, calcium, and magnesium at different stages of intrauterine life.

Strong confirmation of this has recently been obtained from investigation of farm animals. The experiments of Steenbeck and Hart show that the production of milk in cows and goats causes a heavy drain upon the calcium of the skeleton unless the amount of calcium contained in the food be very abundant.

A comparison of the types of food and their percentages in dietaries of Americans and of the Los Baños mess students is given in Table VI. Comparison is made to show how a good Filipino dietary would compare with the average American diet. The figures for the American diet were taken from Sherman's *Chemistry of Food and Nutrition* (page 391).

TABLE VI.—*Relative calories furnished by American and Filipino dietary.*

Foodstuffs.	American Dietary.		Filipino Dietary.	
	Calories.	Cost.	Calories.	Cost.
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Meats and fish.....	16.54	33.19	11.35	31.30
Eggs.....	1.75	5.55	2.22	9.04
Milk.....	8.11	9.08	0.78	2.41
Cheese.....	0.94	1.13	—	—
Butter and other fats.....	10.29	8.14	0.50	1.56
Grain products.....	37.79	17.85	75.16	31.81
Sugar and molasses.....	10.78	3.80	2.40	1.16
Vegetables.....	9.03	9.12	7.06	20.67
Fruits.....	3.87	6.03	—	—
Nuts.....	0.27	0.35	—	—
Miscellaneous.....	0.63	5.76	0.53	2.05

Table VI shows that, in what we would consider a good Filipino diet, grain products supply 75.16 per cent of the calories, while animal products supply only 11.35 per cent. It also shows that animal protein constitutes 30.88 per cent of the total protein and that the grains furnish over one half (57.10 per cent) of the total protein. While the vitamine carriers in the American diet (eggs, milk, cheese, vegetables, butter, fruits) furnish 33.99 per cent of the total calories; in the student mess dietary the vitamine carriers constitute only 10.55 per cent and in the diet of the peasant families they are in even smaller proportion, only about 5 per cent. It is thus apparent that the so called protective foods constitute only a small percentage of our diet. Only about 15 per cent of our food as against 40 per cent of the American, is of animal origin. Milk and dairy products, which according to McCollum are the protective foods *par excellence* constitute an insignificant part of our dietary. In other words, the

animal food we eat is mostly meat (pork) and fish. With a mixture similar to the food of the Los Baños families, McCollum has been unable to induce maximum development in his laboratory animals. While his studies were made with laboratory animals, their applicability to human nutrition is now generally admitted since, "Laboratory results are fully paralleled in human experience, and evidence of this sort tends to increase." (22)

In his studies of the dietary properties of rice, the cereal that constitutes 85 per cent of the diet of our common people, McCollum found that it is deficient in four respects: (1) The poor quality and quantity of its proteins; (2) the poor quality of its mineral salts; (3) the absence of vitamine A; and (4) the absence of vitamine B. We may add that rice lacks, also, vitamine C. The use of meat and fish corrects one of these deficiencies, the quality and proportion of protein; but it does not correct the others. The vegetables introduce the lacking vitamins and the mineral salts, but the proportion taken in our food just places us in the "twilight zone," where "small shifts in the quality of the diet with respect to any factor may either distinctly stabilize metabolic process of the animal or may lead to the development of a distinct pathological state."

Although we may not be wholly warranted in making our studies in Los Baños applicable to other parts of the Islands, yet common observation shows that the trend of nutrition is the same all over the archipelago, in that rice constitutes a large percentage of the Filipino diet and that milk and milk products are used to a very limited extent, if at all.

The extensive nutrition investigation of physiological chemists all over the world has emphasized the great importance of milk in the diet. McCollum says:

There can be no doubt that there is great lack of knowledge by the people generally as to the importance of milk and other dairy products in the diet. There is no single substitute for milk (so far as we know) and its use should be distinctly increased instead of diminished, regardless of cost. Every possible means should be employed to reduce the cost of distribution. The necessity for the liberal use of milk and its products is emphasized in order to stem the ebbing tide of its production. It has been pointed out that the value of milk as a food cannot be estimated on the basis of its content of protein and energy. Even when measured by this standard it compares most favorably with other foods, but it has a value as a protective food, in improving the quality of the diet, which can be estimated only in terms of health and efficiency.

An examination of any large groups of people in the cities will show that where there is a high mortality from tuberculosis, milk is not being used to any great extent, and in any large group where milk purchases are large this disease is not a menace. It is well known that in institutions where tuberculosis is successfully treated milk forms the principal article of the diet of the inmates. This has resulted from clinical experience. There is no other effective treatment for this disease than that of providing fresh air, insisting upon rest and of heightening the body's powers of resistance through the liberal use of milk for the correction of faults which the diet will inevitably have when it consists too largely of seed products, tubers, roots and meats. The importance of diets of this character in the etiology of tuberculosis, has not hitherto been appreciated. There can be no reasonable doubt that the importance of poor hygienic conditions and of poor ventilation have been greatly over-estimated, and that of poor diet not at all adequately appreciated as factors in promoting the spread of this disease. Milk is just as necessary in the diet of the adult as in that of the growing child. Any diet which will not support normal development in the young will not support optimum well-being in the adult. Milk is our greatest protective food, and its use must be increased.

The appalling infant mortality in the Islands¹ is paralleled by McCollum's experience in the laboratory with diets not including milk products. In our limited experiments in Los Baños with albino rats, we have, also, found that the foodstuffs such as we use in our mess, allowing the rats free choice, would maintain adult animals in equilibrium; but would induce a high mortality among the young. McCollum's (7) statement in connection with the need for milk in the diet, is clear cut and worth very serious consideration. If we are to reduce the appalling infant mortality in our country, as well as increase our resistance to disease, that we may attain our maximum development as a race, we need to greatly improve our diet so that it will include more vegetables and milk.

The fact that our importation of dairy products has increased several times during the past ten years is a good sign, as it shows that we are gradually realizing the value of milk as food. But our needs for this important food product can only be met by increasing the home production and all efforts should be made to develop a dairy industry in the Islands. The fact, that even the farmers out in the country do not show any better food intake than the urban population, is indication that our poor diet is as much the result of false economy as of poor dietary habit brought about by an incomplete knowledge of food values. The families we studied in Los Baños, according to figures that we have on hand, had enough income to enjoy a better diet. I believe that the main reason for their low food intake was that the diet was poor in vitamine, which, according to Mendel, has something to do with the development of appetite. This habit of subsisting on diet largely composed of rice and fish is not limited to the poor people, only, but it is quite common, even among the well-to-do. It is well known that beri-beri and infant mortality are also frequent among the well-to-do. The use of highly seasoned meat (mostly pork) and rice with a very limited amount of vegetables is general among all classes of Filipinos. There is a danger in the eating of vitamine-poor diet since such people may fall in the vicious circle referred to by Mendel, which may finally result in nutritive collapse.

¹ The 1918 Census of the Philippine Islands gives the following figures:

Convulsions of infants.....	23,350
Congenital debility, etc.....	13,866
Infantile beri-beri.....	10,159
Influenza.....	6,616
Acute bronchitis.....	6,034
Malaria.....	6,766
Diarrhoea and enteritis (under 2 years).....	4,069
Cause of death not specified or ill-defined.....	4,053
Smallpox.....	2,738
Tetanus.....	1,481
Meningitis.....	1,457
Lack of care.....	1,373
Whooping cough.....	1,242
Bronchopneumonia.....	1,215
Other causes peculiar to early infancy.....	1,008
Total.....	93,427

for a total population of 10,000,000, or a rate of about 9 per 1000.

It may be safely stated that a very large percentage of these deaths could be traced to faulty diets of the mothers as the predisposing cause. Doctor Albert of the College of Medicine and Surgery in a conversation with the author admitted the possibility of faulty calcium metabolism as the predisposing cause of convulsions in infants. The work of a number of investigators has established relation between calcium retention and deficiency in vitamine A or a substance associated with it. With a dietary, such as that of the Los Baños families, the chances for low vitamine and calcium intake are indeed very great.

ECONOMICAL PHASE OF THE DIET OF THE FILIPINO

In what direction should the improvement be effected? Our studies of the diet of people in Los Baños indicate that the Filipino dietary may be deficient in:

1. Proteins (because of low intake)
2. Vitamines
3. Calcium

In our present knowledge of nutrition, the surest and safest way of correcting all three deficiencies is by the liberal use of milk in addition to the vegetables in the diet. For milk will correct with fair efficacy all the deficiencies at once. Milk, at its present cost, is inaccessible to the poor, so that for the time being, and while we are developing our dairy industry, our diet should be corrected, so far as possible, by the more liberal use of the vegetables like green *paayap*¹ tomatoes and others that are particularly rich in vitamines and calcium. By a greater consumption of these vegetables, a larger intake of food will be stimulated and the plane of protein intake will *ipso facto* be raised. The proportion of protein in our diet is in agreement with what has been found sufficient in nutrition experiments, 14 per cent of which about one-third is animal protein. The intake of protein is naturally low, because of low food intake, but if 2800 to 3000 calories are taken, instead of 2200, the amount of protein eaten will be correspondingly greater. In the case of children and expectant mothers and nursing-women, the proportion should be increased by the inclusion of milk in the diet, whenever possible. It is safe to state from what is known of properties of food, that the safety of both the mother and her infant depends entirely on her ability to include milk in her diet. My own personal experience with our laboratory animals and in my own family, is in agreement with this contention. It may be of course possible to supplement these deficiencies by using certain vegetables, but our knowledge of this is still very scant and the safety of our people can not be as easily secured by the use of a greater variety of these vegetables.

The great difficulty in the use of vegetables as protective foods is on account of their bulkiness. Leaves of plants and vegetables like tomatoes and beans when in fresh condition, contain a large amount of water and are therefore too bulky to be eaten in quantities sufficient to correct all the deficiencies of rice. Moreover, the leaves of some plants and other vegetables are not easily digested in the stomach, and may cause stomach disturbances by their contents of tannin or alkaloids. The modern conception of nutrition shows the nature of the deficiency in our food and from the point of view of the health and optimum development of the race, no other government endeavor and activity should be considered as important and praiseworthy as the thorough study of the dietary properties of our foodstuffs. This study should attempt to discover the foods most easily accessible that are best adapted to correct the nutritive deficiencies of rice. If necessary the manufacture of vitamine preparations in the form of tablets,² as suggested by McClendon (23), could be undertaken by the Govern-

¹ *Panyap* is native cowpea.

² J. F. McClendon writing in *Science* said: There are many families who do not, under the present system, receive sufficient vitamines in their food. Therefore, some addition seems necessary, but this is clearly considered as an addition, and not as a substitute for anything. These additions may be in the form of dehydrated products. Many of the vegetables and fruits may be dehydrated and consumed in a form which will furnish the consumer

ment for distribution, at cost, among the needy, to be used as a regular part of the diet, and not in case of illness, only. McCollum has also recommended that the need for calcium be supplied by adding calcium carbonate to the diet, either in cooking or with the salt. The manufacture of dehydrated fruits and legumes should be encouraged, since it is of common experience that vegetables are hard to get in many localities during certain seasons of the year, in spite of the fact that in the Philippines we should be able to grow crops the whole year around. A study of vegetable crop rotation should be undertaken with the view to finding the most desirable plants, from the point of view of nutrition, as well as practicability in planting, to grow in the different seasons of the year and for different localities. In the meanwhile both chemical and biological analysis of our foodstuffs should be actively pushed. The use of unpolished rice advocated by many physiologists, while excellent in principle, finds an obstacle in the desire of people for a more refined rice product, since both the taste and cooking quality of the unpolished rice make the demand for it rather limited. Consequently, rice mill owners find it less profitable to produce this kind of rice than the polished. Forcing people by legislation to eat something they dislike is fraught with dangers and great difficulties. Besides, the use of unpolished rice would mitigate but not remedy our food situation. The deficiency in the Filipino diet should be remedied along a more effective and practical direction: the encouragement of a greater and cheaper vegetable production and the fostering of the dairy industry in the Islands.

Proper dietary for the Filipino is a question that is fundamental and social. The government should help in improving the conditions in the most effective and urgent manner possible. This would be not so much by legislation as by a nation-wide campaign of enlightenment and education in food values among the people. Much has been accomplished in our country in sanitation. But as Doctor Concepción has said, sanitation alone will not solve the problem of health and of infant mortality in the Islands.

You physicians and pharmacists of the country can help a great deal in this campaign for better food among the poor. The respect and awe the medical profession commands from the people is proverbial. Your advice in this connection will have a more far-reaching effect than that of any other body of men. You can be a potent factor in the improvement of the health and stamina of our peasants and laboring class by spreading among them the doctrine of good dietary. The question of their getting food is not so much an economic question as it is a question of choosing the *right kind*.

BIBLIOGRAPHY

- (1) VOIT, CARL. *Cited by* L. B. Mendel in *New York State Journal of Medicine*, July, 1920.
- (2) HOPKINS, F. G. In *Analyst* 31: 395. 1906.

with considerable vitamines, and yet not necessitate a change in the methods of preparation of foods by the family. Those dehydrated vegetables may contain vitamins A and B, and dehydrated fruits may, under certain circumstances, contain in addition some vitamin C. The dietary habits of various persons, however, form an obstacle to the consumption of sufficient vitamins. There are also many persons who can relish fresh foods (spinach, for instance) when they can not stomach dehydrated foods (spinach). The peel of citrus fruits and some other fruits, is very rich in vitamins, yet no one eats them. For those persons who do not relish certain vitamin-containing vegetable products, the use of tablets containing these products, that may be swallowed whole, seems desirable. Orange peelings ground in a meat chopper, dried and ground in a coffee mill may be made into tablets by the addition of dehydrated orange juice acting as a binder. Such tablets contain vitamins A, B and C. Ground spinach may be similarly made into tablets with orange juice. I have tried these preparations on animals and determined their effectiveness in regard to vitamin content.

3. ELKMAN, C. *In* Archives of the Journal of Hygiene 58: 150. 1906.
4. FRAZER, H., and STANTON, A. T. The etiology of beri-beri. Study 12 of the Institute of Medical Research, Federated Malay States. Lancet, March 12, 1910: 733.
5. STEPP, W. *In* Biochemische Zeitschrift 22: 452. 1909; Zeitschrift für Biologie 57: 135. 1912; *Ibid* 59: 366. 1912-1913.
6. FUNK, C. *In* Lancet 2: 1266. 1911.
7. MCCOLLUM, E. V. The newer knowledge of nutrition. 199 pp. New York, 1920.
8. OSBORNE, T. B. and MENDEL, L. B. *In* Journal of Biological Chemistry 16: 431. 1913.
9. MCCOLLUM, E. V., and KENNEDY, C. *In* Journal of Biological Chemistry 24: 491. 1916.
10. COHEN, B., and MENDEL, L. B. *In* Journal of Biological Chemistry 31: 3. 1918.
11. MENDEL, L. B. The fat soluble vitamine. New York State Journal of Medicine, July, 1920.
12. HENRIQUES and HANSEN. *In* Zeitschrift für Physiologische Chemie 48: 417. 1905.
13. OSBORNE, T. B. and MENDEL, L. B. *In* Journal of Biological Chemistry 12: 473. 1912; 13: 233. 1912; 17: 325. 1914; 18: 1. 1914; 20: 351. 1915; 22: 241. 1915; 25: 1. 1916; 26: 1. 293. 1916.
14. MENDEL, L. B. Food factors in gastro-enterology. American Journal of the Medical Science 158: 297. 1919.
15. BARNARD. The use of raw eggs in practical dietetics. American Journal of the Medical Sciences 152: 841. 1917.
16. FARRIS, E., GROSSCHMIDT, M. and FRANK, A. Cited by L. B. Mendel in New York State Journal of Medicine, July, 1920.
17. MCCOLLUM, E. V. and others. Cited by H. C. Sherman in The chemistry of food and nutrition. 314 pp. New York, 1919.
18. ARNOLD. Vitamine symposium: Thermostability of vitamines. Journal of Industrial and Engineering Chemistry 13: 1102-1116. 1921.
19. SHERMAN, H. C. The chemistry of food and nutrition. 314 pp. New York, 1919.
20. OSMOND. A study of the nutrition of Filipinos. Revista Filipina de Medicina y Farmacia 10: 202. 1919.
21. *Loc. Cit.* 264.
22. HANSEN, P. G. Newer aspects of the nutrition problem. Journal of Industrial and Engineering Chemistry 14: 64. 1922.
23. MCCOLLUM, T. F. The use of vitamin food tablets as an aid towards conserving the food supply. Science, October 28, 1921.
24. FARRIS, E. B., STRASSBURG, H., and HUBBARD, C. A. *In* Journal of Biological Chemistry 48: 95. 1921.
25. JONES, HENRY, and HANSEN, P. Rice as food. Philippine Journal of Science 6-B: 371. 1911.
26. JONATHAN. The present state of knowledge concerning necessary food factors. *In* Report of the Labor Institute and the Medical Research Committee. Australian Science, August 13, 1921.

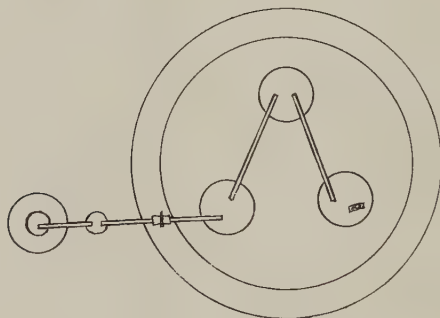
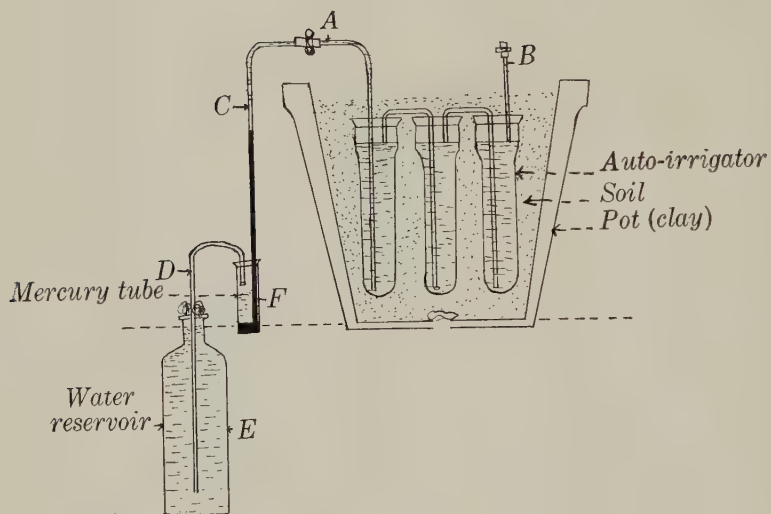


Figure 1—Auto-irrigating apparatus.

THE CONTROL OF SOIL MOISTURE BY MEANS OF AUTO-IRRIGATORS¹

By FERNANDO DE PERALTA
Of the Department of Plant Physiology

INTRODUCTION

Livingston and Koketsu are of the opinion that "As far as plant water-relations are concerned, a soil is satisfactory for growth if it can supply water to the root system as rapidly as the latter can absorb it". They believe also that "The rate of external water supply does not become a limiting condition for growth until this rate falls below the rate of absorption demanded by the internal conditions of the plant". They admit, however, "That if the soil is not capable of supplying moisture to the root system as rapidly as the latter can take it up, then the soil moisture complex becomes a limiting condition for growth", and "That as long as such a state of affairs prevails the growth of the plant and other features of its activity, must be more or less markedly different from what they would be if water were more rapidly furnished to the roots". (1)

With these points in mind, the writer decided to find out the relation of the growth of lettuce to different soil moisture contents when the amount of moisture in the soil is controlled by modification of Livingston's auto-irrigator method. (2)

The work was carried out at the College of Agriculture, Los Baños, during the year, 1921.

MATERIALS AND METHOD

THE EQUIPMENT USED

Livingston's auto-irrigators No. 1 were used in earthen pots capable of holding five kilograms of dry soil. The irrigators provided a constant supply of water to the cultures in the pots. These cups (auto-irrigators) were connected by glass tubing and tightly stoppered. The arrangement is shown by the diagram, Figure 1.

The cups were placed vertically in the pot in such a way that if an isosceles triangle were to be drawn, the cups would be located at the three vertices of the triangle, as shown in Figure 1, top view.

At A, side view, a glass tube C, bent at a right angle, was connected. The lower end of tube C was inserted through one of the holes of a two-holed rubber stopper to the bottom of the mercury tube, F. Mercury was put into the tube. The volume of the mercury in each case was just enough to produce in the different pots, when the suction force producing the column was being applied at point A, a definite height of the mercury column: that is, the column was 5

¹ Thesis presented for the degree of Master of Science from the College of Agriculture, No. 142, Experiment Station contribution, No. 86.

centimeters high in one pot, 10 in another, 20 in another, and 40 in another. This mercury tube was partially filled with water. In the other hole of the stopper holding the mercury tube, another tube D, was inserted. The free end of it was placed in the water reservoir, E.

Before the auto-irrigators were put in the culture pots, they were filled with water. The apparatus from the lower end of tube C, through A to B, was completely filled with water. After this, a known weight of dry soil was poured in the pot.

Kind of soil used.—Three parts of well-pulverized loam and one part of coarse sand, thoroughly mixed, were used in the pots. The water-retaining power of the mixture was determined as follows:—Hilgard's pans were filled with oven-dry soil. The weight of the soil and pan was taken. Then the pan was placed over water and kept there until the soil was saturated. After this, the water was allowed to drip for twenty-four hours in a moist chamber. At the end of the period the soil and the pan were weighed again. The percentage of increase in weight over the first weight obtained (that is expressing same as a percentage of dry weight) is the *water-retaining power of the soil*. The water-retaining power of the mixture was found to be 43.6 per cent. The moisture content of the air-dry soil was 8.6 per cent expressed as a percentage on dry weight basis.

Plant used and its preparation.—Lettuce (*Lactuca sativa*.) was used. It was chosen because a plant of this kind can be grown to full size in the earthen pots here employed. Previous experiments had shown that this plant responds readily to different soil moisture contents which further suggested the utility of this plant for this experiment.

The seeds were first sown in seed flats. The seedlings were pricked to another seed flat where they were allowed to remain until they had three well-developed leaves.

EXPERIMENTAL TECHNIQUE

Control of soil moisture.—By the use of his auto-irrigators, Livingston found that changing the height of water column (increasing the vertical distance from the reservoir) materially changed the percentage of soil moisture in the medium. In the present study instead of varying the height of water columns to regulate the entrance of water into the culture medium, mercury was used as shown in Figure 1. Five pots without mercury were set up in such a way that the water level in the reservoir was even with the bottom of the pot containing the soil, so that a column of water would not have to be lifted, and so that a state of equilibrium of water would exist between pot and reservoir. In these pots the water column was considered zero and the amount of water available to the plant depended only upon the ability of the soil to take up water through the auto-irrigator. Five other pots were set up as follows: five with five centimeters height of mercury, five with ten, five with twenty, and five with forty. These will be designated as the zero column, the ten, the twenty, and the forty centimeters columns, respectively. The height of mercury was controlled as stated in the description of Figure 1.

Preliminary experiments showed that the amount of water given off to the soil in pots by the porous cups varies according to the height of the column

of mercury in the tube, the longer the column, the less water supplied to the soil. This of course is what would be expected, because, other conditions remaining the same, a longer column of mercury offers more friction to the flow of water through the tube where the mercury is held, than a shorter column. The preliminary trials of this study gave the following data showing the variation of water absorbed when pulling against different mercury columns.

TABLE I. *The effect of different mercury columns on total water absorbed.*

Mercury columns.	No. of days before equilibrium.	Total amount of water absorbed.	Average absorbed per column.
		<i>c.c.</i>	<i>c.c.</i>
0-centimeter column.....	70	266.8	263.75
	72	269.6	
	70	262.2	
	74	256.4	
5-centimeter column.....	79	148.8	148.56
	80	137.3	
	80	144.1	
	80	160.8	
	82	151.8	
10-centimeter column.....	82	126.5	127.35
	80	125.9	
	82	129.4	
	81	127.6	
20-centimeter column.....	88	93.9	92.22
	85	89.7	
	89	93.3	
	87	96.7	
	88	87.4	
40-centimeter column.....	92	49.5	47.1
	92	60.4	
	96	45.0	
	92	33.5	

Before planting, the percentage of soil moisture in the culture pots was determined. The samples were taken from the center of the pots in each of the sets. A cork borer two and one-half centimeters in diameter was employed. The results of the determinations were used as a basis for the computation of the amount of water necessary to make the water content of the hand-watered pots equal to those auto-irrigated. The percentage of soil moisture content (pots watered periodically) was then maintained constant by weighing the pots every other day and by adding the required amount of water lost in weight through evaporation and later by transpiration, until the original weight was reached. Thus five sets of cultures containing 25.11 per cent, 14.43 per cent, 12.29 per cent, 10.4 per cent, and 9.39 per cent of moisture were set up parallel with the auto-irrigated cultures. The figures given above were obtained by taking the average of the averages of the different columns of mercury obtained from the determinations made on August 11 and 18, 1921. These determinations are shown in Table II. The determination on August 3 was not used, because the later determinations at that time showed that the soil was still absorbing water.

Table II shows the percentage of soil moisture present in the soil based on dry weight, determined at weekly intervals before and after the plants were harvested.

TABLE II. *Soil moisture determination of the soil in culture pots before planting and after harvesting on the basis of dry weight.*

Mercury Columns.	Before Planting.			After Harvest.
	Aug. 3, 1921.	August 11.	August 18.	
	<i>per cent.</i>	<i>per cent.</i>	<i>per cent.</i>	<i>per cent.</i>
0-centimeter column.....	23.98	26.30	26.0	25.8
	23.02	24.30	24.2	24.0
	20.50	24.00	24.0	24.1
	23.30	25.70	25.5	25.7
	22.96	25.70	25.4	26.0
Average.....	22.75	25.20	25.02	25.1
5-centimeter column.....	16.00	14.90	15.9	16.0
	15.20	14.70	15.2	15.0
	12.80	13.90	12.9	12.8
	13.20	16.0	13.0	13.0
	14.00	13.8	14.0	13.7
Average.....	14.40	14.66	14.2	14.1
10-centimeter column.....	11.0	11.5	10.9	11.0
	12.7	13.6	13.0	12.5
	11.6	11.7	11.5	11.0
	11.1	12.4	11.0	11.0
	13.6	13.8	13.5	13.2
Average.....	12.0	12.6	11.99	11.7
20-centimeter column.....	10.2	10.7	10.1	10.1
	10.0	10.8	10.0	9.5
	10.0	10.3	10.2	9.6
	10.6	10.7	10.6	11.0
	10.2	10.6	10.3	10.0
Average.....	10.2	10.6	10.2	9.84
40-centimeter column.....	8.0	9.66	8.4	8.0
	9.0	9.6	9.0	8.7
	9.4	9.83	9.3	9.0
	9.6	8.83	9.8	9.0
	9.4	9.75	9.8	9.2
Average.....	9.08	9.53	9.26	8.78

Transplanting.—On August 20, the plants were transplanted to the culture pots. (Pots auto-irrigated and pots watered periodically.) One plant was planted in each of the different sets, leaving one pot blank. Each plant used had three leaves. When first planted in the pots they were approximately equal in size and leaf area.

Measurement.—The plants were measured weekly after they were transplanted. The length and width of each of the leaves were taken to represent the comparative growth of each plant.

In some of the pots the plants wilted on hot dry days. The time of the day when the plants wilted and also the atmospheric conditions at the time of wilting were carefully noted.

Harvest.—The plants were harvested when they had attained the approximate maximum growth. Before harvesting, the leaves were measured. The plants were cut just below the lowest leaf produced. The outline of the leaves of each of the plants was carefully traced on blank paper. The area of each leaf was then determined by the use of a planimeter. The leaves were then air dried and weighed.

RESULTS

The results are presented in tables as follows:

Table III shows the average total weekly measurements, leaf products (length times width) of all the leaves of plants in the auto-irrigated pots.

Table IV shows the weekly measurements of the hand-watered pots.

Table V shows the comparative average vegetative growth (expressed in actual leaf areas determined by tracing the margin of the leaves by the use of the planimeter) and the dry weights (air-dry) of the entire plants from both auto-irrigated and hand-watered pots.

Table VI presents the conditions of the air when the plants wilted.

Table VII summarizes the average of the three determinations of the atmospheric conditions when the plants growing in the different auto-irrigated pots showed signs of wilting.

TABLE III. *Weekly measurements of the plants in the different auto-irrigated pots.*

Mercury columns.	Date planted.	Leaf product in square centimeters.			
		Measured Aug. 27.	Measured Sept. 3.	Measured Sept. 10.	Measured Sept. 17.
		<i>sq. cm.</i>	<i>sq. cm.</i>	<i>sq. cm.</i>	<i>sq. cm.</i>
0-centimeter column.....	Aug. 20, 1921	155.78	276.74	364.18	425.69
5-centimeter column.....	"	76.41	149.01	229.34	308.67
10-centimeter column.....	"	66.02	108.61	181.93	245.86
20-centimeter column.....	"	34.82	50.48	77.91	104.90
40-centimeter column.....	"	32.83	41.24	60.44	82.77

TABLE IV. *Weekly measurements of the plant in the different percentages of soil moisture (hand-watered).*

Per cent of soil moisture.	Date planted.	Leaf product in square centimeters.			
		Measured Aug. 27.	Measured Sept. 3.	Measured Sept. 10.	Measured Sept. 17.
		<i>sq. cm.</i>	<i>sq. cm.</i>	<i>sq. cm.</i>	<i>sq. cm.</i>
25.11	Aug. 27, 1921	124.98	103.73	250.29	365.17
14.43	"	92.96	111.68	170.25	213.00
12.29	"	50.16	88.51	120.44	124.41
10.4	"	45.07	41.33	53.68	58.45
9.39	"	27.80	36.35	38.60	43.77

TABLE V. *Comparative dry weights and total leaf areas of plants in auto-irrigated and hand-watered pots.*

Mercury column.	Per cent of soil moisture in pots.	Leaf area in square cm.			Dry weight in grams.		
		Plants auto-irrigated.	Plants watered periodically.	Gain in per cent.	Plants auto-irrigated.	Plants watered periodically.	Gain in per cent.
		sq. cm.	sq. cm.		gm.	gm.	
0-centimeter column....	25.11	221.05	190.55	16.0	5.66	3.22	75.8
5-centimeter column....	14.43	144.6	112.75	28.0	3.9	2.84	37.0
10-centimeter column...	12.29	123.5	93.15	34.0	2.52	2.0	26.0
20-centimeter column...	10.40	58.4	25.35	130.0	1.15	1.0	15.0
40-centimeter column...	9.39	42.8	16.75	155.0	0.88	0.83	6.0

TABLE VI. *Wilting point determination.*

Date and hour of observation.	Atmometer reading.			Air temperature in °C.	Observation. ^a
	Black.	White.	Insolation.		
	<i>c. c.</i>	<i>c. c.</i>			
9-14- 8:00	0.0	0.0		27.2	
9-14- 9:00	1.75	1.17	0.58	28.3	Plt. began to wilt 40-cm.
9-14-10:00	2.47	1.49	0.98	29.4	Plt. began to wilt 20-cm.
9-14-11:00	2.08	1.49	0.59	31.7	Plt. began to wilt 10-cm.
9-14-12:00	3.10	1.94	1.16	32.6	
9-14- 1:00	3.54	2.35	1.19	31.4	Plt. began to wilt 5-cm.
9-14- 2:00	3.54	2.35	1.19	31.5	

^a Plants planted in the pots having zero column did not wilt at all throughout the whole day.

					Observation ^a
9-15- 7:00	0.0	0.0		24.0	
9-15- 8:00	0.34	0.27	0.07	27.1	Plt. began to wilt 40-cm.
9-15- 9:00	2.81	1.35	1.46	28.0	Plt. began to wilt 20-cm.
9-15-10:00	2.81	1.80	1.01	29.0	Plt. began to wilt 10-cm.
9-15-11:00	2.91	1.98	0.93	30.0	Plt. began to wilt 5-cm.
9-15-12:00	3.01	2.12	0.89	30.7	
9-15- 1:00	2.81	2.30	0.51	31.2	
9-15- 2:00	3.35	2.30	1.05	30.9	

^a Plants planted in the pots having zero column did not wilt at all throughout the whole day.

					Observation ^a
9-16- 7:00	0.0	0.0		24.0	
9-16- 8:00	0.63	0.50	0.13	27.0	Plt. began to wilt 40-cm.
9-16- 9:00	2.28	1.08	1.20	28.8	Plt. began to wilt 20-cm.
9-16-10:00	2.81	1.53	1.28	28.8	Plt. began to wilt 10-cm.
9-16-11:00	3.88	1.94	1.94	30.2	
9-16-12:00	3.64	2.07	1.57	31.0	Plt. began to wilt 5-cm.
9-16- 1:00	3.69	2.70	0.99	30.9	
9-16- 2:00	3.88	1.97	1.91	30.5	

^a Plants planted in the pots having zero column did not wilt at all throughout the whole day.

TABLE VII. *Average atmospheric conditions when the plants in the different pots showed signs of wilting.*

Mercury columns.	Average Atmometer reading in cc.		Insolation in cc.	Air temperature °C.
	Black.	White.		
4-centimeter column.....	0.91	0.65	0.26	27.5
20-centimeter column.....	2.52	1.31	1.21	28.7
10-centimeter column.....	2.57	1.61	9.96	29.8
5-centimeter column.....	3.39	2.18	1.22	31.0
0-centimeter column.....	Did not wilt at all.			

DISCUSSION OF RESULTS

Table II shows the moisture contents of the media under the conditions of the various mercury columns. It gives the conditions both before planting and after harvesting. From these results two things may be deduced: First, the regulation of the entrance of water into the soil by means of auto-irrigators and mercury columns kept the soil content of the pots fairly constant. Second, the percentage of soil moisture in the pots after harvest was about one per cent lower than before planting. The deviation was so small that it would not affect the result of the experiment. Hence, differences in development of the plants (plants watered periodically and plants auto-irrigated) may be considered due directly to the efficiency of the two methods used.

The weekly measurements of the plants (leaf products), given in Table III, show that the plants auto-irrigated had greater leaf area than the plants watered periodically. This is better shown in Table IV or its graph, Figure 2.

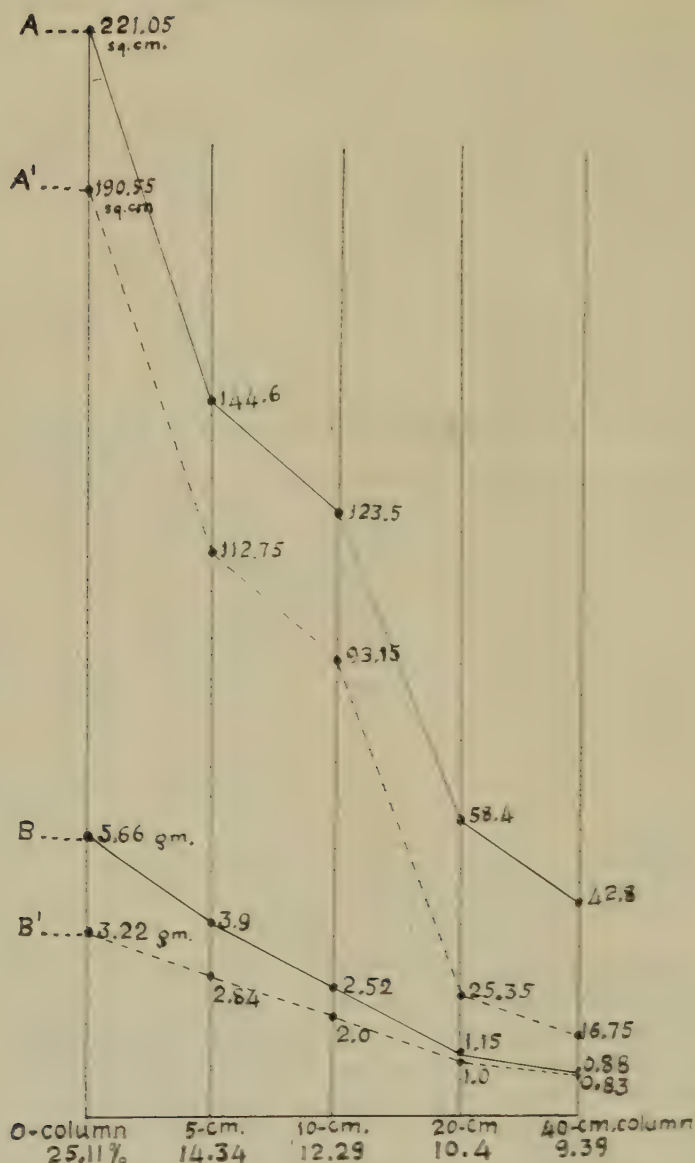


Figure 2

A—Leaf area in sq. cm. of plants auto-irrigated.
 A'—Leaf area in sq. cm. of plants watered periodically.
 B—Dry weight in gm. of plants auto-irrigated.
 B'—Dry weight in gm. of plants watered periodically.

Figure 2 shows, drawn to the same scale, the graphs of leaf areas and dry weights of both the hand-watered and auto-irrigated plants. The dry weight and leaf area graphs of the auto-irrigated are both decidedly higher than the graphs of the corresponding hand-watered plants. As stated before the hand-watered plants received as much water as the plants auto-irrigated. It was the way of watering not the amount that differed. The constant supplying of water seemed to make the water more available to the plant. This verifies Daniel (3) and Hawkin's (4) statement that garden plants supplied with water permitted

to percolate continuously, but very slowly, were found to develop more rapidly than plants spasmodically watered in the ordinary way. After each watering by the hand method the plant must pass through a cycle from an excessive water supply to an inadequate water supply which terminates only with the next watering. Therefore during part of the cycle the growth of the hand-watered plants must be retarded. In this connection it should be mentioned that the hand-watered plants all wilted on days when they were not due to be watered. Referring to Table V, the plants auto-irrigated at zero column of mercury were 16 per cent larger in total leaf area and 75.8 per cent heavier in dry weight than the plants grown in the hand-watered pots which also contained 25.11 per cent

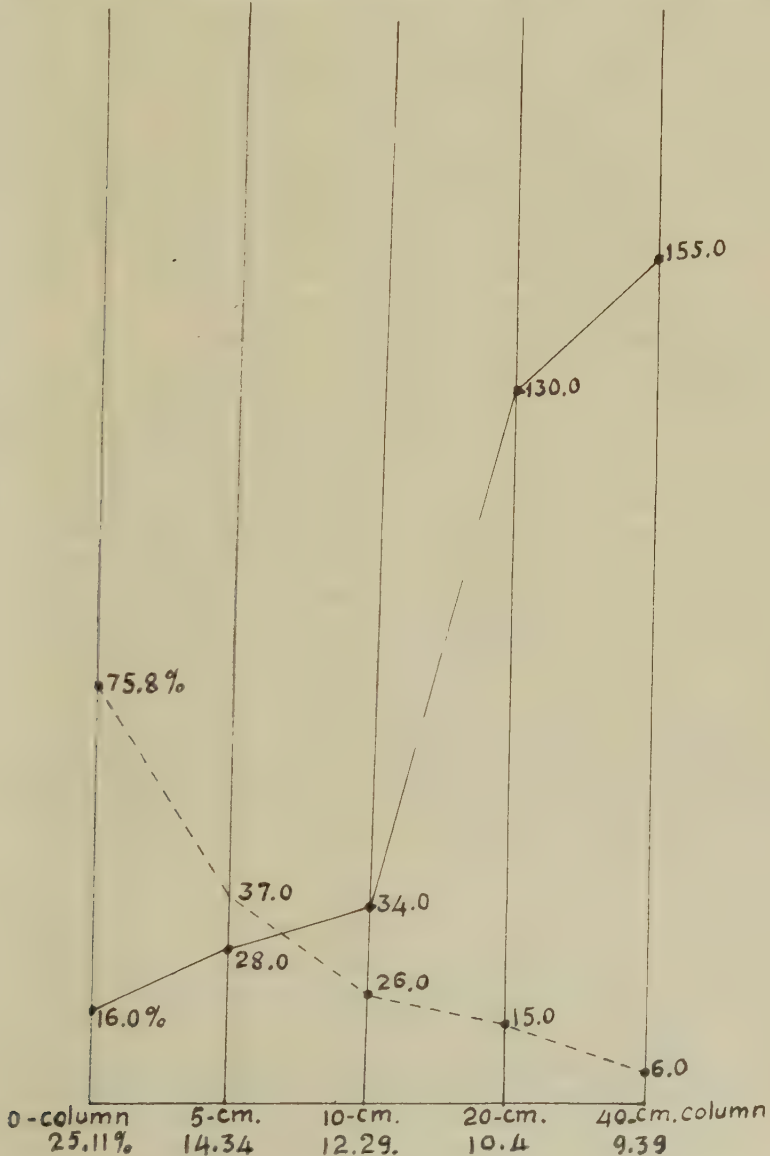


Figure 3

Per cent dry weight gain.....
 Per cent leaf area gain.....

of soil moisture but were watered periodically. The plants from the pots with the 5-centimeter column of mercury showed an increase of 28 per cent in leaf area and 37 per cent increase in dry weight over the corresponding hand-watered plants; those from the 10-centimeter column pots showed an increase of 34 per cent in leaf area and 26 per cent in dry weight; those from the 20-centimeter column pots showed an increase of 130 per cent in leaf area and 15 per cent in dry weight; and those from the 40-centimeter column pots showed an increase of 155 per cent in leaf area and 6 per cent in dry weight. Figure 3 shows these increases in weight and leaf area plotted to the same scale.

Examination of Figure 3 shows that the curves representing the increase in leaf area are directly reverse, though not proportionately reverse, to the curve showing the gain in dry weight. Figure 2, as stated in the discussion, shows that an increase in available soil moisture (decrease in height of mercury column) gives an increase in both dry weight and leaf area. (See Graph 2.) From Graph 3 it is evident that the greater the available water supply, as limited by conditions of the experiment, the greater the gain in dry weight. The reverse curve of leaf area shows that the gain in leaf area decreases with an increase in water supply. Examination of Graph 3 also shows that the gain curves cross with a column of between five and ten centimeters which would represent total moisture supply of approximately 13 per cent.

The efficiency of the auto-irrigator method is strikingly shown by these two gain curves. By the auto-irrigator method 25.11 per cent of moisture supplied produced a gain of only 16 per cent in leaf area, but in dry weight the auto-irrigated plants have a gain of 75.8 per cent. Since gain in dry weight implies a gain in cell content, this gain from the use of the auto-irrigator may be interpreted as one of 16 per cent in appearance and 75.8 per cent in quality. The pots with lower moisture content showed a checking of growth, but even in these pots the auto-irrigated plants gained in size and dry weight. When under conditions of very inefficient moisture supply, the gain in leaf area by auto-irrigation was enormous. Thus, when the soil moisture was only 9.30 per cent, the gain in leaf area was 155 per cent, with only a small gain of 6 per cent in dry weight. In interpreting these results it must be remembered that the hand-watered plants were in a wilted condition for a longer time than the auto-irrigated. Since turgescence is one of the prime factors for growth, the variation in wilting may be considered to explain in part the curve of leaf area gain.

In explanation of the reverse dry weight curve it must be remembered that the hand-watered pots passed through a cycle from a more or less saturated to a very dry condition, which extended to the next watering. In the case of the 9.39 per cent moisture supply, perhaps the saturation stimulus enabled the hand-watered plants almost to keep up (only 6 per cent gain in dry weight) with the auto-irrigated plants. That is, too little water all the time produced a little more dry weight and much more vegetative body than just enough water supplied at intervals. In the case of the plants in the 9.39 per cent pots the leaves of the auto-irrigated plants were somewhat thinner.

According to the data in Table VI, giving atmometer and temperature readings, it is evident that in this locality when the temperature is not less than

24°C and not more than 28°C, and the rate of evaporation from the black atmometer is not less than 0.34 cc and not more than 1.75 cc per hour, the plants in the soil pulling against a forty centimeter mercury column as by the condition of the experiment, would begin to wilt. Roughly averaging these data it may be stated that when the temperature is 27°C and the rate of evaporation is about 1.0 cc per hour the water supplied by the forty centimeter column of mercury apparatus is just below the wilting coefficient.

Table VII is made up by taking similar averages. This table expresses the usability of the various auto-irrigator sets under different atmospheric conditions. In certain experiments, it is sometimes necessary to keep the plants growing in a water supply that is constantly just a few degrees above the wilting coefficient. The data here presented may be used as a guide in setting up such an experiment. It is to be noted in particular that the plants grown in pots without mercury did not wilt at all throughout the course of the experiment. This fact shows that when the temperature is not higher than 31°C and the rate of evaporation from the black atmometer is not faster than 3.39 cc per hour, plants of this kind treated, as here described, will not wilt in a soil, the maximum water content of which is not greater than 25.11 per cent.

CONCLUSION AND RECOMMENDATION

The soil moisture content of soil in pots or any other container could be very well regulated and its water content kept almost constant (certainly without any significant fluctuation) for an indefinite period by the use of auto-irrigators and mercury columns according to the method given in the first part of this paper.

In the case of the plant, lettuce, a noteworthy gain in both leaf area and dry weight was secured by the use of auto-irrigator method.

The usability of the method in terms of climatic factors is given in tabular form, (Table VII). The constancy with which the soil moisture may be maintained by the use of auto-irrigators would make the method most applicable for some types of physiological and ecological experiments.

ACKNOWLEDGEMENT

I am indebted to Dr. Forman T. McLean, formerly head of the Department of Plant Physiology of this College who suggested the subject of this investigation and who helped me in the preliminary part of this work. I am especially indebted to Associate Professor Frank P. McWhorter of the Department for his assistance during the investigation.

BIBLIOGRAPHY

- (1) LIVINGSTON, B. E., AND KOKETSU, R. The water supplying power of the soil as related to the wilting of plants. *Soil Science* 9: p. 470.
- (2) LIVINGSTON, B. E. A method for controlling plant moisture. *Plant World*. 11: 39-40. 1908.
- (3) DANIEL, L. The effect of continuously supplying water to the plants by capillarity. (*Compt. Rend-Acad. Sci. (Paris)* 163 (1916) No. 19, pp. 525-527. *Abstract in Experiment Station Record* 37: p. 325.
- (4) HAWKINS, LON A. The porous clay cup for the automatic watering of plants. *Plant World*. 13: 220-27. 1910.

UNIVERSITY OF THE PHILIPPINES

COLLEGE OF AGRICULTURE

LOS BAÑOS, LAGUNA

ANNOUNCEMENT 1922-1923

CALENDAR 1922-23

First semester

June 5-13, 1922.....	Registration
June 14.....	Opening of first semester
July 4.....	Holiday
August 14.....	Holiday
October 19-28.....	First semester examinations
October 28.....	Closing of first semester

Second semester

November 1.....	Opening of second semester
November 30.....	Holiday
December 15.....	University day
December 17.....	Opening of Christmas recess
January 8, 1923.....	Resumption of classes
February 22.....	Holiday
March 12-17.....	Final examinations
March 23.....	Faculty meeting
March 26.....	Council meeting
March 26.....	Regents meeting
April 4.....	Commencement

**UNIVERSITY OF THE PHILIPPINES
COLLEGE OF AGRICULTURE**

ADMINISTRATIVE OFFICERS

President of the University: Doctor GUY POTTER BENTON

Dean of the College: Professor CHARLES FULLER BAKER

Registrar: Professor EVETT D. HESTER, Acting

College Physician: Doctor SIXTO A. FRANCISCO

Graduate Study: Professor MANUEL L. ROXAS

Extension Activities: Professor INOCENCIO ELAYDA

Heads of Departments:

Agricultural Chemistry: Professor MANUEL L. ROXAS

Agronomy: Professor JAMES E. HIGGINS

Animal Husbandry: Professor ALONZO S. SHEALY (Acting)

Plant Physiology: Professor DESMOND ANDREW HERBERT

Rural Economics: Professor EVETT D. HESTER

Rural Engineering: Professor.....

English: Associate Professor EMMA S. YULE

Entomology: Professor HAROLD E. WOODWORTH

Plant Pathology: Professor OTTO A. REINKING¹

Chief Clerk: ALFREDO V. YÑIGUEZ

Property Clerk: BENEDICTO ORDOÑEZ

BUSINESS DIRECTORY

Office of the Dean: The office of the Dean is located in the Main Building, Room 1.

Correspondence: Address all correspondence to the Dean, College of Agriculture, Los Baños, Laguna, P. I.

FACULTY

BAKER, CHARLES FULLER, B. S., A. M.,

Dean of the College, Director of the Experiment Station, Professor of Tropical Agriculture.

ELAYDA, INOCENCIO, M. S.,

Professor of Farm Management.

GONZALEZ, BIENVENIDO MARIA, M. S.,¹

Professor of Animal Husbandry.

HERBERT, DESMOND ANDREW, M. Sc.

Professor of Botany.

¹ On leave.

- HESTER, EVETT DORRELL, A. B.,
Professor of Economics.
- HIGGINS, JAMES EDGAR, M. S. A.,
Professor of Agronomy.
- KOPKE, E. W.,
Lecturer on Sugar Technology.
- REINKING, OTTO A., M. S.,¹
Professor of Plant Pathology.
- ROXAS, MANUEL LUZ, Ph. D.,
Professor of Agricultural Chemistry.
- WOODWORTH, HAROLD E., B. S.,
Professor of Entomology.
- MCWHORTER, FRANK P., M. S.,
Associate Professor of Plant Physiology.
- MENDIOLA, NEMESIO BLANCO, Ph. D.,
Associate Professor of Agronomy.
- WELLES, COLLIN G., M. S.,
Associate Professor of Plant Pathology.
- YULE, EMMA S., B. Di.,
Associate Professor of English.
- BRENTON, T. R., B. A.,
Assistant Professor of English.
- ESPINO, RAFAEL B., Ph. D.,
Assistant Professor of Plant Physiology.
- KENWARD, HAZEL, A. B.,
Assistant Professor of Agricultural Chemistry.
- LLENADO, AGUSTIN, *Doctor en Filosofía (Barcelona)*
Assistant Professor of Modern Languages.
- MIRASOL, JOSÉ J., Ph. D.,
Assistant Professor of Agronomy.
- QUISUMBING, FRANCISCO, Ph. D.,
Assistant Professor of Agricultural Chemistry.
- RAYMUNDO, MARIANO B., B. S.,
Assistant Professor of Agronomy.
- ROA, MANUEL A., B. S.,
Assistant Professor of Physics.
- SANTOS, FRANCISCO O., Ph. D.,
Assistant Professor of Agricultural Chemistry.
- TAYLOR, RUTH, B. J.,
Assistant Professor of English.
- UICHANCO, LEOPOLDO B., Sc. D.,
Assistant Professor of Entomology.

¹ On leave.

- VIBAR, TORRIBIO, M. S.,¹
Assistant Professor of Agronomy.
- WELLES, DORIS B., A. B.,
Assistant Professor of History.
- ALDABA, VICENTE C., M. S.,
Instructor in Agronomy.
- ALINCASTRE, CECILIO, M. S.,¹
Instructor in Agricultural Chemistry. (Fellow in Sugar Chemistry and Engineering in the United States.)
- DAVID, PEDRO A., B. S.,
Instructor in Agronomy.
- FRONDA, FRANCISCO, Ph. D.,
Instructor in Animal Husbandry.
- MONDOÑEDO, MARIANO, B. S.,
Instructor in Animal Husbandry.
- OCFEMIA, GERARDO, M. S.,¹
Instructor in Plant Pathology. (Fellow in Plant Pathology in the United States.)
- PAÑGANIBAN, ELIAS, M. S.,
Instructor in Agricultural Chemistry.
- QUISUMBING, EDUARDO, B. Agr.¹
Instructor in Plant Physiology. (Pensionado in Plant Physiology in the United States.)
- VILLEGAS, VALENTE E., B. Agr.¹
Instructor in Animal Husbandry. (Pensionado in Animal Husbandry, in the United States.)
- DAWIS, VICENTE, B. S.,
Assistant Farm Superintendent.
- BONDOC, JOSÉ,
Teacher in Carpentry.
- VIDAL, ALBINO,
Teacher in Blacksmithing.
- ESGUERRA, JOSÉ P., B. S.,
Junior Animal Husbandman.
- LAGO, FRANCISCO P., B. S.,
Junior Animal Husbandman.
- AFRICA, ANGEL, B. S.,
Assistant in Physics.
- AGATI, JULIAN, B. Agr.,
Assistant in Plant Pathology.
- ALAS, BENEDICTO, B. Agr.,
Assistant in Mathematics.
- BALTAZAR, EULALIO, B. S.,
Assistant in Agronomy.

¹ On leave.

- BERNARDO, FRANCISCO C., B. Agr.,
Assistant in Mathematics.
- CAPINPIN, JOSÉ M., B. S.,
Assistant in Agronomy.
- CARAY, ELIAS, B. Agr.,
Assistant in Agricultural Chemistry.
- CENDAÑA, SILVERIO, B. Agr.,
Assistant in Entomology.
- CLEMENTE, LEOPOLDO, B. Agr., ¹
Assistant in Agronomy.
- COLLADO, ESTEBAN, B. S.,
Assistant in Agricultural Chemistry.
- DIVINAGRACIA, DELFIN, B. Agr.,
Assistant in Sugar Technology.
- GAMBOA, FERMIN, B. S.,
Assistant in Agronomy.
- GOCO, LORENZO, B. Agr.,
Assistant in Economics.
- GONZALEZ, LEON G., B. S.,
Assistant in Agronomy.
- JIMENEZ, ALEJO, B. Agr.,
Assistant in Agricultural Chemistry.
- MANZA, ARTEMIO, B. Agr.,
Assistant in Plant Physiology.
- MARIANO, SEVERO J., B. Agr., ²
Assistant in Agronomy.
- PERALTA, FERNANDO DE, B. S.,
Assistant in Plant Physiology.
- PUNZALAN, EDILBERTO, B. Agr.,
Assistant in Agronomy.
- REYES, ANTONIO, B. Agr.,
Assistant in Mathematics.
- REYES, TEODORICO, B. Agr.,
Assistant in Agronomy.
- ROCAFORT, ANTONIO, B. Agr.,
Assistant in Physics.
- RODRIGO, PEDRO, B. Agr.,
Assistant in Agronomy.
- ROLDAN, EMILIANO, B. S.,
Assistant in Plant Pathology.
- SULIT, VICTOR, B. S.,
Assistant in Agricultural Chemistry.

¹ On leave.

- TALEON, ALEJO T., B. S.,
Assistant in Animal Husbandry.
- URETA, ELIGIO, B. Agr.,
Assistant in Agricultural Chemistry.
- VILLADOLID, DEOGRACIAS, B. S.,
Assistant in Entomology.

GENERAL INFORMATION

History

The College of Agriculture was the first college to be organized as a part of the University, beginning its class work June 4, 1909. During this year Dean Copeland brought to the site of the College twelve students and instruction was begun in tents borrowed from the Bureau of Education. By October 1909, the first building was completed. The enrollment at the end of the year was 56. It was necessary for the first faculty and the early students of the College to literally carve their institution out of the wilderness. The work that they did was prodigious and stands as a monument to their pioneering instinct. From its very small beginning, the College has grown constantly until it now maintains a registration of upward of 600 students, presents over one hundred courses of instruction divided into six curricula and has a faculty of 68 members.

Location

The College of Agriculture is located on a first class road, four kilometers from the town of Los Baños. It is accessible to Manila by motor car, by the southern branch of the Manila railroad, and by the Yangco steamboat line on Lake Bay.

Organization

The College of Agriculture is organized to follow three main lines of activity: resident instruction, research, and extension, and certain subsidiary services.

Resident instruction embraces nine departments: Agricultural Chemistry including Sugar Technology, Agronomy including Horticulture and Management, Animal Husbandry, English including other Modern Languages, Entomology including Zoology, Plant Pathology, Plant Physiology, Rural Economics including Farm Accounting, and Rural Engineering including Physics and Mathematics. Administration of instruction rests in the faculty and the Dean.

Research is carried on by the nine departments acting for the Experiment Station. Administration of research rests in the Director of the Experiment Station and the Faculty Executive Committee composed of the heads of the nine departments of instruction.

Extension activity was unorganized until 1921 when a beginning was made by placing this important function in the hands of the Professor of Farm Management who for this purpose acts directly under the Dean and may require the cooperation of the departments of instruction.

Service embraces: transportation, building construction, maintenance of property, and water and light operated by the Department of Engineering; maintenance of farm and campus operated by the Department of Agronomy; sanitation and health under immediate jurisdiction of the College Physician,

graduate study, library, publications, curricula, athletics, and social activities are administered by committees of the faculty. In all service arms the Dean maintains active authority.

Administration of College functions is effected by the Dean and Director through five entities: The Faculty, Registrar, Chief Clerk, Disbursing Officer, and Property Clerk.

The College of Agriculture interlocks with the College of Veterinary Science as follows: General subjects of instruction are given for both Colleges in the College of Agriculture; Veterinary subjects in Animal Husbandry are given by the College of Veterinary Science. The College of Agriculture also exchanges subjects with the School of Forestry.

Equipment

The College of Agriculture occupies and operates 377 hectares of land at the foot of Mount Makiling near Lake Bay in the Province of Laguna. Mount Maquiling itself is held under the Bureau of Forestry as a reserve and contains the National Botanic Gardens.

The College has sixteen concrete and one mixed material buildings of permanent character aside from numerous temporary wooden and native material structures. The scientific departments are well equipped to carry on the essential instruction and research activities of tropical agriculture.

The Department of Agronomy possesses a well selected body of implements, tools, geared plows and cultivators, and three tractors. This department maintains over 3000 cultures in progress and permanent plantings totaling 25000 individuals. The department from 1909-21 distributed plants, cuttings, seeds, and samples to the number of over 900,000.

The Department of Animal Husbandry maintains herds of native, Indian, and Hereford cattle, swine, carabao, stallions and brood mares, and operates in co-operation with the Bureau of Agriculture a poultry experiment station.

The Department of Engineering maintains a water system by which pure mountain water is delivered underground to all parts of the Campus, a suitable electric plant supplying lights to residences and halls, and power to the laboratories, well equipped shops for construction and repair, and two trucks and a passenger bus for transport.

The Department of Chemistry has a model, small-scale sugar mill so constructed as to enable the student to see each process in the manufacture of sugar and to perform "going" exercises in sugar technology.

The Department of Plant Pathology is supervisor over the local citrus collection of the United States Department of Agriculture. This department houses the Baker Indo-Malayan Mycological Collection.

The Department of Entomology has an extensive Indo-Malayan Entomological Collection, largely the gift of Dean Baker. The Hawaiian Sugar Planter's Association in 1921 presented a commodious and well furnished insectary which together with two minor insectaries and a silk house are important aids to the department.

The Department of Plant Physiology is in possession of an herbarium of over ten thousand sheets bearing largely on local flora.

The Library is poorly housed in two rooms of the Administration Building and consists of some 4000 bound volumes and 10,000 pamphlets on technical agriculture. The Library receives annually over 1000 periodicals and bulletins through exchange with *The Philippine Agriculturist*. A suitable library building and a permanent, full-time, trained librarian are foremost needs of the College.

The valuation of the entire plant of the College of Agriculture is ₱371,805. The annual appropriation is at present ₱402,880. The average present annual cost of operation per student is about ₱690.

Experiment Station

The Experiment Station of the College of Agriculture was established by Act No. 2730, 1918, of the Philippine Legislature and consists of approximately 300 hectares of land. The Dean of the College is Director of the Experiment Station. Since the establishment of the Station no funds have been appropriated for its operation. The limited development has been achieved through savings from funds primarily educational.

The Philippine Agriculturist

The Philippine Agriculturist was established in 1909 and has issued continuously to the present as the official organ of the College. The year's volume consists of ten numbers of from three to four hundred pages. It has published over three thousand pages of original studies and investigations by the faculty and students of the College. The Student Body Association has voluntarily made subscription to the journal a prerequisite to membership.

Student Life

The students of the College of Agriculture are housed in three ways: (1) In government dormitories of which there are fourteen holding from six to thirty-six students each; (2) In club houses built and owned by the students, individually, in fraternities, and by the Student Body Association, to the number of about twenty; (3) In boarding and lodging houses in the Coconut Grove, San Antonio, and Los Baños.

The College operates a refectory for about one third the total number of students. Many students run co-operative commissaries.

Students of the College own and operate the College Co-operative Co., Inc., which sells text-books, school supplies, clothing, and groceries at low rates. Students are also stockholders in the Cine Maquilting which furnishes moving picture entertainments on Fridays and Saturdays.

All students are members of the Student Body Association which maintains effective control over all parochial, social, and athletic activities and assists effectively in the general discipline of the institution, constituting to a large degree a very democratic and practical self-governing community.

There are Protestant and Roman Catholic chapels on land adjoining the Campus.

The living expenses of the average student of the College fall between twenty and twenty-five pesos a month. About one third of the students work their own way through, largely as student day laborers and assistants on the College pay roll. Students entering the College should in all cases come pre-

pared to pay the necessary fees as below prescribed and should be prepared financially for at least the first four months as it generally takes some time for the average student to get on a self-supporting basis.

Medical Attendance

The College employs a physician and a graduate nurse who have offices and a dispensary on the Campus. Minor cases are treated locally, but students with serious or infectious diseases are sent to Manila to the Philippine General Hospital.

Military Drill and Physical Training

As with other students of the University, those enrolled in the College of Agriculture are required to attend military drill three hours weekly throughout the first two years, and physical training one hour weekly throughout the first year of residence.

Fees

No tuition is charged at the College of Agriculture. The educational opportunities offered are free to all students, foreign or native. There are no fixed laboratory fees; but each student is required to keep always on deposit with the College ₱15.00 to cover destruction and loss of property. Balances remaining in deposit are returned to the student when he leaves the College. In addition students are required to pay in advance of registration a small Student Body Association levy amounting usually to ₱5.20 for the first semester and ₱1.20 for the second semester or summer session.

Student Advisers

Shortly after the beginning of each school year, each student is assigned to a member of the professorial staff for guidance and advice not only as to subjects to be taken but also in regard to their relations with other students, with the College, and for necessary disciplinary supervision. At the beginning of the student's third collegiate year, or upon the election of his major, he is re-assigned to be advised by a member of the department in which he is working his major. All students in the Sugar Technology curriculum are assigned to the professorial staff of the Department of Chemistry. All students working in the Animal Husbandry curricula are assigned to the professorial staff of the Department of Animal Husbandry.

Admission

Applicants for admission to the College of Agriculture must present themselves in person to the Registrar during the period of registration, pass a physical examination to the satisfaction of the College Physician, make a deposit with the Disbursing Officer (₱15), pay in advance the levies of the student Body Association (₱5.20 for first semester and ₱1.20 for second semester or summer session) and present scholastic credentials to the Registrar on one of the following bases:

(1) Satisfactory completion of a high school course including: *Algebra*, $1\frac{1}{2}$ units; *Plane Geometry*, 1 unit; *English*, 3 units; *Biology*, *Botany*, or *Zoology* or a combination thereof, 1 unit; *History*, 1 unit; *Physics*, 1 unit; and *Electives*, $5\frac{1}{2}$ units. Applicants on this basis are admitted to the common first year of the curricula for students of high school accomplishment.

(2) Satisfactory completion of the various Intermediate school courses prescribed by the Bureau of Education of the Philippine Islands or equivalent

courses in foreign schools. The question of equivalency shall be decided by the Dean. Applicants on this basis are admitted to the common first year preparatory of the curricula for students of intermediate school accomplishment.

(3) Applicants holding the degree of *Bachelor of Agriculture* from the College are admitted to the *Bachelor of Agriculture to Bachelor of Science Make-up Curriculum*.

(4) Candidates for the degree of *Master of Science* are admitted by the Chairman of the Committee on Graduate Study, Professor Roxas, in accordance with the rules of the University Committee on Graduate Study. Such candidates should apply directly to Professor Roxas and not to the Registrar.

(5) Special students, not to become candidates for degrees, are admitted at the pleasure of the Dean of the College.

Advanced standing is attained in any curriculum upon presentation of documentary evidence accepted by the Registrar as indicating completion of work substantially equivalent to that for which it is to stand in lieu. Advanced standing is particularly applicable to students who have completed one, two, or three years of high school work. The Registrar reports all grants of advanced standing to the first succeeding faculty meeting and at that time the faculty may correct or revoke the grant and require re-registration of the student.

CURRICULA FOR STUDENTS OF HIGH SCHOOL ACCOMPLISHMENT

The Four Year General Curriculum

Year and subjects	Units		Year and subjects	Units	
	1st Sem.	2nd Sem.		1st Sem.	2nd Sem.
I Collegiate:			II Collegiate:		
English 4.....	5		Agric'l Chemistry 2.....	5	5
Mathematics 5.....		3	Zoology 1.....	5	5
Pl. Physiology 2...	4	4	Physics 2.....		5
Agric'l Chemistry 1.	5	5	Rural Economics 3.	2	2
Rural Economics 2.	3	3	Agronomy 4.....	5	
Agronomy 1.....	2	2	Agronomy 5.....	5	5
Agronomy 2.....	3				
Agronomy 3.....		5			
	22	22		22	22
I Summer:			III Collegiate:		
Farm Experience A.			Entomology 1.....	5	
Farm Experience B.			Pl. Pathology 1....		5
Farm Experience C.			Agric'l Engineering 1	4	4
			Agronomy 6.....	5	5
			Major.....	5	5
				19	19
			IV Collegiate:		
			Animal Husbandry 1	4	4
			Elective.....	5	5
			Major.....	10	10
				19	19
Total units.....				164	

The Four Year Animal Husbandry Curriculum

Year and Subjects	Units		Year and Subjects	Units	
	1st Sem.	2nd Sem.		1st Sem.	2nd Sem.
I College Year			III College Year		
English 4	5		Agronomy 7	5	
Mathematics 5		3	Agronomy 14		3
Pl. Physiology 2	4	4	Animal Husbandry 2	2	3
Agric'l Chemistry 1	5	5	Animal Husbandry 3		3
Rural Economics 2	3	3	V. S. Anatomy 6	5	
Agronomy 1	2	2	V. S. Gen'l Bacteriology 14	3	
Agronomy 2	3		V.S. Medicine 6. Common Diseases		3
Agronomy 3		5	V. S. Medicine. Equitation		2
	22	22	Major	5	5
				20	21
II College Year			IV College Year		
Farm Experience A			Agric'l Engineering 6	4	4
Farm Experience B			Electricity	5	4
Farm Experience C			Major	14	14
III College Year					
Agric'l Chemistry 2	5	5			
Zoology 1	5	5			
Physics 2		5			
Rural Economics 3	2	2			
Agronomy 4	5				
Animal Husbandry 1	4	4			
	21	21		19	18
Total units					962

The Sugar Technology Curriculum

	Units			Units	
	1st Sem.	2nd Sem.		1st Sem.	2nd Sem.
<i>I Collegiate:</i>			<i>III Summer:</i>		
English 4.....	5		Sugar Mill Practice		
Mathematics 5.....		3	A.....		
Pl. Physiology 2....	4	4			
Agric'l Chemistry 1..	5	5	<i>IV Collegiate:</i>		
Rural Economics 2..	3	3	Agric'l Chemistry 103	5	
Agronomy 1.....	2	2	Agric'l Chemistry 104		5
Agronomy 2.....	3		Agronomy 101.....		5
Agronomy 3.....		5	Agric'l Engineering 4	5	
	22	22	Agric'l Engineering 5		5
			Animal Husbandry 1	4	4
<i>I Summer:</i>			Elective.....	5	
Mathematics 6.....	5			19	19
<i>II Collegiate:</i>			<i>IV Summer:</i>		
Spanish 1.....	3	3	Sugar Mill Practice		
Agric'l Chemistry 2..	5	5	B.....		
Agric'l Chemistry 3..	5	5			
Physics 2.....		5	<i>V Collegiate:</i>		
Rural Economics 3..	2	2	Agric'l Chemistry		
Agronomy 4.....	5		105.....		5
	20	20	Agric'l Chemistry		
			150.....	8	5
<i>III Collegiate:</i>			Agric'l Chemistry		
Spanish 2.....	3	3	199.....	1	1
Mathematics 7.....		5	Rural Economics 5..		3
Agric'l Chemistry 101	5	5	Agronomy 7.....	5	
Agric'l Chemistry 102	5		Agronomy 8.....		5
Entomology 1.....	5		Agronomy 103.....	5	
Pl. Pathology 1....		5			
Agric'l Engineering 1	4	4			
	22	22		19	19
<i>Total units.....</i>					209

CURRICULA FOR STUDENTS OF INTERMEDIATE SCHOOL ACCOMPLISHMENT

The Six Year General Curriculum

Year and Subjects	Units		Year and Subjects	Units	
	1st Sem.	2nd Sem.		1st Sem.	2nd Sem.
<i>I Preparatory:</i>			<i>II Collegiate:</i>		
English 1.....	5	5	English 3.....	5	5
Mathematics 1.....	5	5	Agric'l Chemistry 2.	5	5
Pl. Physiology 1...	4	4	Physics 2.....		5
Agronomy 1.....	2	2	Rural Economics 3.	2	2
Rural Economics 1.	2	2	Agronomy 4.....	5	
			Agronomy 5.....	5	5
	18	18		22	22
<i>I Summer:</i>			<i>III Collegiate:</i>		
Farm Experience A.			Entomology 1.....	5	
Farm Experience B.			Pl. Pathology 1....		5
Farm Experience C.			Agric'l Engineering 1	4	4
			Agronomy 6.....	5	5
			Major.....	5	5
				19	19
<i>II Preparatory:</i>			<i>IV Collegiate:</i>		
English 2.....	5	5	Animal Husbandry 1	4	4
Mathematics 2.....	5	5	Elective.....	5	5
Physics 1.....	3	3	Major.....	10	10
Zoology 1.....	5	5			
	18	18			
<i>I Collegiate:</i>					
Mathematics 3.....	5				
Mathematics 5.....		3			
Agric'l Chemistry 1.	5	5			
Pl. Physiology 2...	4	4			
Rural Economics 2.	3	3			
Agronomy 2.....	3				
Agronomy 3.....		5			
	20	20		19	19
<i>Total units.....</i>					232

The Six Year Animal Husbandry Curriculum

Year and subjects.	Units.		Year and subjects.	Units.	
	1st Sem.	2nd Sem.		1st Sem.	2nd Sem.
<i>I Preparatory:</i>			<i>II Collegiate:</i>		
English 1.....	5	5	English 3.....	5	5
Mathematics 1.....	5	5	Agric'l Chemistry 2.	5	5
Pl. Physiology 1....	4	4	Physics 2.....		5
Agronomy 1.....	2	2	Rural Economics 3.	2	2
Rural Economics 1.	2	2	Agronomy 4.....	5	
			Animal Husbandry 1	4	4
	18	18		21	21
<i>I Summer:</i>			<i>III Collegiate:</i>		
Farm Experience A.			Agronomy 7.....	5	
Farm Experience B.			Agronomy 14.....		5
Farm Experience C.			Animal Husbandry 2	2	3
			Animal Husbandry 3		3
			V. S. Anatomy.... 6	5	
			V. S. Gen'l Bateria-		
			logy..... 1a	3	
			V. S. Common Dis-		3
			eases.....		2
			V. S. Equitation....		5
			Major.....	5	
	18	18		20	21
<i>II Preparatory:</i>			<i>IV Collegiate:</i>		
English 2.....	5	5	Agric'l Engineering 1	4	4
Mathematics 2.....	5	5	Elective.....	5	4
Physics 1.....	3	3	Major.....	10	10
Zoology 1.....	5	5			
	18	18		19	18
<i>I Collegiate:</i>					
Mathematics 3.....	5				
Mathematics 5.....		3			
Agric'l Chemistry 1.	5	5			
Pl. Physiology 2....	4	4			
Rural Economics 2.	3	3			
Agronomy 2.....	3				
Agronomy 3.....		5			
	20	20			

Total units..... 232

CURRICULUM FOR HOLDERS OF B. AGR. DEGREE

The Bachelor of Agriculture to Bachelor of Science Make-up Curriculum

Group of subjects.	Units.	Group of subjects.	Units.
<i>I Of preparatory or collegiate grade:</i>		<i>II Of collegiate grade:</i>	
History.....	20	Agricultural or scientific....	10
English Composition or			
Literature.....	10		
Optional Academic.....	20		

Total units..... 60

REGULATIONS RELATIVE TO CURRICULA

Election of Curriculum

The student of intermediate school accomplishment finds that the two years preparatory, summer preparatory and first year collegiate of the Six Year General and the Six Year Animal Husbandry curricula are identical. Upon admission to the College the student does not indicate his choice, but before entering the second year collegiate he notifies the Registrar of his election.

Likewise the student of high school accomplishment finds that the first year collegiate of the Four Year General, the Four Year Animal Husbandry, and the Sugar Technology curricula are identical. Election is reported at the beginning of the first summer if the choice is the Sugar Technology curriculum and at the beginning of the second year if the choice is between the Four Year General and the Four Year Animal Husbandry curricula.

Clearance of Subjects

All students are required to clear all previous work before entering their second year collegiate in any curriculum. Exception in clearance of subjects may be granted by the Secretary in the case of special students, of regular students when a conflict occurs between two or more subjects, or of students having advanced standing.

The Unit

The unit, semester hour, or credit in the College of Agriculture is defined as one lecture, recitation or quiz of 50 minutes duration or the equivalent thereof in laboratory, field, or shop work. Laboratory, field, or shop work is credited at the rate of one unit for each three hour period, part or all of one hour of which may be work assigned outside of class hours such as field trips or specimen collecting.

Prerequisites

Prerequisites for any subject are determined as follows: (1) General prerequisites constitute all subjects of the same department assigned in the regular curriculum for a previous year. These prerequisites may be set aside by the Dean upon recommendation of the Registrar. (2) For subjects not required in any curriculum, prerequisites are at the pleasure of the head of the department in which the subject is given.

Majors

In the Four Year General, the Four Year Animal Husbandry, the Six Year General, and the Six Year Animal Husbandry curricula 30 units are assigned to major. The major represents concentration within a department. The subjects which constitute the major are prescribed by the head of the department in which the student makes his election. Election of major in any curricula must be made at or prior to the beginning of the student's third year of Collegiate work. At this time the Head of the Department in which the student has elected to major will prescribe a definite major program covering the 30 units including a thesis.

Students in the Animal Husbandry curricula major in poultry, swine, cattle, or horse husbandry.

Theses

Each major includes a thesis based upon original investigation of the student, approved by the faculty and carrying a credit of 10 units. The thesis outline

must be presented by the student to the Registrar on call of the head of the department. The preliminary outline is approved by the Executive Committee before the student begins his actual work on the thesis.

Electives

Provision is made in all curricula for a limited number of units to be utilized by the student as he may choose. Any subject of collegiate grade given in the College may be presented as an elective, except as follows: (1) Subjects required in the curriculum in which the student is working. (2) Subjects required in the preparatory years or first collegiate year of any curriculum.

Ratings

Ratings in the College of Agriculture are 1, 2, and 3, which in descending order designate degrees of excellence in satisfactory work, 4 for conditioned work, and 5 for failure. A condition may be removed as follows: (1) By completion, if a tutoring course is offered during the summer session subsequent to the year in which condition was attained. (2) By examination during the first week of June of the school year subsequent to that in which the condition was attained. A rating of 5 requires repetition of the entire subject with a rating of 3 or better if credit is to be had.

Scholarship Rules

Changes in registration.—Changes in registration except for compulsory dropping of subjects are not permitted after July 31 of the pertinent school year.

Dropping of subjects.—Dropping of subjects is accomplished by: (1) Election of the student on or before July 31 of the pertinent school year. In this case no rating is given for the subject. (2) Compulsion initiated by the Dean, Registrar, or the adviser of the student concerned because of illness, outside work, or ill-advised registration. (3) Compulsion initiated by the Registrar because of delinquency as defined below.

Delinquency.—An average of ratings and check is made on the basis of June, July, and August reports of instructors and every two months thereafter. If at any such period a student has an average rating of 5 in one subject or of 4 in two subjects he is designated as delinquent in that subject and receives first warning.

Probation.—If a student delinquent in any subject does not show marked improvement in that subject at the next subsequent check period he is dropped from the subject, receives a final rating of 5 therein, is placed on probation, and receives second warning. Students on probation may not continue in the employ of the College either as assistants or laborers.

Extreme delinquency.—Extreme delinquency is designated for those students who at any check period have an average rating of 5 in two subjects, 5 in one subject and 4 in two subjects, or 4 in four subjects. A student under this designation need not have been previously under *delinquency* or on *probation*. Students designated under extreme delinquency are suspended from the College until the opening of the next school year.

Removal of extreme delinquency.—For suitable cause the Dean of the College may release a student from the penalty of extreme delinquency, but the student remains so designated until his scholarship shows great improvement.

Property Clearance

Before leaving the Campus of the College of Agriculture at the end of the school year, when leaving school, or upon being sent down by suspension, expulsion, or for physical disability, a student is required to obtain a property clearance from all heads of departments, the librarian, store-keepers, property officers, the Registrar and the Disbursing Officer of the College.

Graduation

Upon completion of the requirements of any one of the curricula and the presentation of property clearance, the student is recommended to the University Council, and through that body to the Board of Regents of the University of the Philippines for graduation with degree as follows: (1) For the Four Year General, Four Year Animal Husbandry, and *Bachelor of Agriculture to Bachelor of Science* Make-up curricula, the degree of *Bachelor of Science in Agriculture*. (2) For the Sugar Technology curriculum, the degree of *Bachelor of Science in Agriculture with Certificate in Sugar Technology*. (3) For the Six Year General and Six Year Animal Husbandry curricula, the degree of *Bachelor of Agriculture*.

SUBJECTS OF THE CURRICULA

AGRICULTURAL CHEMISTRY

For undergraduates

Agricultural Chemistry 1—General Chemistry. First and second semesters. 10 units. (I/1)¹

Agricultural Chemistry 2—Analytical and Agricultural Chemistry. First and second semesters. 10 units. (II/2)

Agricultural Chemistry 3—The Compounds of Carbon. First and second semesters. 10 units. (IVa, 5 units/3)

Agricultural Chemistry 4—Nutrition. Summer. 3 units.

Agricultural Chemistry 99—Special Problems. By arrangement. 1 to 6 units. (IX/9/109).

Agricultural Chemistry 100—Undergraduate Thesis. By arrangement. 10 units. (X/10)

Informal subjects for undergraduates

Sugar Mill Practice A. Summer. Informal credit.

Sugar Mill Practice B. Summer. Informal credit.

For undergraduates and graduates

Agricultural Chemistry 101—Advanced Agricultural Analysis. First and second semesters. 10 units. (4)

Agricultural Chemistry 102—Physical Chemistry. First semester. 5 units. (5)

Agricultural Chemistry 103—Industrial Chemistry. First semester. 5 units. (7)

Agricultural Chemistry 104—Chemistry of the Sugars. Second semester. 5 units. (IVb/6)

Agricultural Chemistry 105—Sugar Factory Control. Second semester. 5 units. (Sugar Technology 1).

Agricultural Chemistry 150—Thesis in Sugar Technology. By arrangement. 13 units. (Sugar Technology 10).

Agricultural Chemistry 199—Seminar. First and second semesters. 2 units. (Sugar Technology 2).

For graduates

Agricultural Chemistry 201 Biological Chemistry. Second semester. 5 units. (Vb/8)

Agricultural Chemistry 202—History of Chemistry. First semester. 5 units.

Agricultural Chemistry 300—Master's Thesis. By arrangement. 10 units.

AGRONOMY

For undergraduates

Agronomy 1—Seasonal Crop Practice. First and second semesters. 4 units. (Practical work/Farm Management /1/2)

Agronomy 2—Elementary Geology. First semester. 3 units.

Agronomy 3—Principles of Crop Production. Second semester. 5 units. (Ia/3a/3)

¹ Designations in parentheses indicate equivalent subjects in former curricula.

- Agronomy 4 Elementary Soil Science. First semester. 5 units (1b 3b 22)
 Agronomy 5 Philippine Crops A. First and second semesters. 10 units
 Agronomy 6 Philippine Crops B. First and second semesters. 10 units
 Agronomy 7 Principles of Breeding. First semester. 5 units (Va 18)
 Agronomy 8 Methods of Plant Breeding. Second semester. 5 units (Vb 19)
 Agronomy 9 Farm Management. First semester. 5 units. (4)
 Agronomy 10 Soil Physics and Management. First semester. 5 units (23)
 Agronomy 11 Coffee, Cacao and Spices. First semester. 5 units (111d 8)
 Agronomy 12 Tobacco. Second semester. 5 units. (111b 12)
 Agronomy 13 Cereals and Legumes. First and second semesters. 10 units. (13)
 Agronomy 14 Forage and Pasture Plants. Second semester. 5 units. (14)
 Agronomy 15 Fiber Plants. First and second semesters. 5 units. (11b 15)
 Agronomy 16 Coconuts and Other Oil Plants. First and second semesters. 5 units. (11a 16)
 Agronomy 17 Rubber Plants. Second semester. 5 units. (111c 21, 3 units)
 Agronomy 18 Tropical Oleiculture. Second semester. 5 units. (IVa 7)
 Agronomy 19 Tropical Pomology. First and second semesters. 10 units. (IVb, 5 units 6)
 Agronomy 20 Coconuts and Abaca. Summer. 5 units. (17)
 Agronomy 99 Special Problems. By arrangement. 1 to 6 units. (IX 9 109)
 Agronomy 100 Undergraduate Thesis. By arrangement. 20 units. (X 10).

Informal subjects for undergraduates

Farm Experience A—Farm and Garden Practice. Summer. Informal credit.

For undergraduates and graduates

- Agronomy 101 Sugar Cane. Second semester. 5 units. (111a 11)
 Agronomy 102 Soil Biology. First semester. 5 units. (24)
 Agronomy 103 Soil Fertility. Second semester. 5 units. (25)
 Agronomy 104 Farm Management Survey. Second semester. 5 units. (5)
 Agronomy 109 Seminar. First and second semesters. 2 units.

For graduates

- Agronomy 201 Advanced Genetics. First and second semesters. 5 units
 Agronomy 202 Methods of Soil Investigation. First and second semesters. 5 units.
 Agronomy 203 Advanced Oil Plants. First and second semesters. 5 units
 Agronomy 204 Advanced Fiber Plants. First and second semesters. 5 units
 Agronomy 300 Master's Thesis. By arrangement. 10 units.

ANIMAL HUSBANDRY

For undergraduates

- Animal Husbandry 1—Principles of Animal Husbandry. First and second semesters. 8 units.¹ (I/1, 10 units)
 Animal Husbandry 2—Feeds and Feeding. First and second semesters. 5 units. (IIa/2)
 Animal Husbandry 3 Animal Breeding. Second semester. 3 units. (IIb/3)
 Animal Husbandry 4—Pedigrees. First semester. 3 units. (4)
 Animal Husbandry 99—Special Problems. By arrangement. 1 to 6 units. (IX/9/109)
 Animal Husbandry 100—Undergraduate Thesis. By arrangement. 10 units. (X/10)

Veterinary subjects for undergraduates

- Veterinary Anatomy 6—Gross Anatomy. First semester. 5 units. (Animal Husbandry 5)
 Veterinary Bacteriology 1—General Bacteriology. First semester. 3 units.
 Veterinary Medicine 5—Common Diseases of Animals. Second semester. 3 units. (Animal Husbandry 6)
 Veterinary Medicine—Equitation. Second semester. 2 units.

For undergraduates and graduates

- Animal Husbandry 101—Cattle Husbandry. First semester. 5 units. (12)
 Animal Husbandry 102—Poultry Husbandry. First or Second semester. 5 units. (7, 3 units)
 Animal Husbandry 103—Dairy Husbandry. First semester. 5 units. (8, 3 units)
 Animal Husbandry 104^a—Swine Husbandry. First semester. 3 units. (11)
 Animal Husbandry 104^b—Swine Husbandry. Second Semester. 2 units.
 Animal Husbandry 199—Seminar. First and second semesters. 2 units.

For graduates

- Animal Husbandry 300—Master's Thesis. By arrangement. 10 units.

ENGLISH

Preparatory

- English 1—English Composition A. First and second semesters. 10 units. (I/1)
 English 2—English Composition B. First and second semesters. 10 units. (II, 2)
 English 12—Introduction to English Literature. Second semester. 5 units.

For undergraduates

- English 3—English Composition. First and second semesters. 10 units.
 English 4—English for Agricultural Students. First semester. 5 units. (3)
 English 5—English for Veterinary Students. First semester. 5 units. (5).

For undergraduates and graduates

- English 101—Advanced English Composition.² First and second semesters. 6 units. (4)

¹ Credited as 10 units for students in former curricula.

² First semester only, 101a, 3 units, required of students in the College of Veterinary Science.

ENTOMOLOGY*For undergraduates*

Zoology 1—Economic Zoology. First and second semesters. 10 units.
(I/1)

Entomology 1—Economic Entomology. First semester. 5 units. (Ia/1)

Entomology 2—Veterinary Entomology. Second semester. 3 units. (Veterinary Zoology 2b)

Entomology 3—Forest Entomology. Second semester. 3 units.

Entomology 99—Special Problems. By arrangement. 1 to 6 units.
(IX/9/109)

Entomology 100—Undergraduate Thesis. By arrangement. 10 units.
(X/10)

For undergraduates and graduates

Entomology 101—Advanced Economic Entomology. First and second semesters. 10 units. (II/3)

Entomology 199—Seminar. First and second semesters. 2 units.

For graduates

Entomology 201—Systematic Entomology. First and second semesters. 10 units.

Entomology 300—Master's Thesis. By arrangement. 10 units.

HISTORY*Preparatory*

History 1—General History. First and second semesters. 10 units. (1)

History 2—American History. First semester. 5 units. (2)

History 3—United States and Philippine Government. Second semester. 5 units. (3)

History 4—Philippine History. Second semester. 5 units. (4)

History 5—Oriental History. Second semester. 5 units. (5)

MODERN LANGUAGES*For undergraduates*

Spanish 1—Beginning Spanish. First and second semesters. 6 units.
(1, 10 units)

Spanish 2—Intermediate Spanish. First and second semesters. 6 units.
(2, 10 units)

German 1—Beginning German. First and second semesters. 6 units.
(I, 10 units)

German 2—Intermediate German. First and second semesters. 6 units.¹
(II, 10 units)

French 1—Beginning French. First and second semesters. 6 units.

French 2—Intermediate French. First and second semesters. 6 units.

PLANT PATHOLOGY*For undergraduates*

Plant Pathology 1—General Plant Pathology. Second semester. 5 units.
(Ia/1)

¹ Given as a 10 units subject 1922-23.

Plant Pathology 2—Plant Disease Control. First semester. 5 units. (1b)

Plant Pathology 99—Special Problems. By arrangement. 1 to 6 units.
(IX/9/109)

Plant Pathology 100—Undergraduate Thesis. By arrangement. 10 units.
(X/10)

For undergraduates and graduates

Plant Pathology 101—Plant Pathology Technique. First and second semesters. 10 units. (2)

Plant Pathology 102—Advanced Plant Pathology Technique. First and second semesters. 10 units.

Plant Pathology 199—Seminar. First and second semesters. 2 units.

For graduates

Plant Pathology 201—Advanced Plant Pathology. First and second semesters. 10 units. (3)

Plant Pathology 300—Master's Thesis. By arrangement. 10 units.

PLANT PHYSIOLOGY

Preparatory

Plant Physiology 1—Elementary Botany. First and second semesters. 8 units.¹ (I/1, 10 units)

For undergraduates

Plant Physiology 2—Plant Physiology. First and second semesters. 8 units.¹ (II/2)

Plant Physiology 3—Veterinary Botany. Second semester. 3 units.

Plant Physiology 99—Special Problems. By arrangement. 1 to 6 units.
(IX/9/109)

Plant Physiology 100—Undergraduate Thesis. By arrangement. 10 units.
(X/10)

For undergraduates and graduates

Plant Physiology 101—Plant Nutrition. Summer and first semester or first and second semesters. 10 units. (III/3, 10 units)

Plant Physiology 102—Advanced Plant Morphology. Second semester. 5 units.

Plant Physiology 103—Short Course in Advanced Plant Morphology. Summer. 3 units.

Plant Physiology 104—Agricultural Climatology. First semester. 5 units.
(5)

Plant Physiology 199—Seminar. First and second semesters. 2 units.

For graduates

Plant Physiology 201—Botanical Microtechnique. Summer and first semester or first and second semesters. 10 units.

Plant Physiology 202—Plant Growth and Movement. First and second semesters. 10 units.

Plant Physiology 300—Master's Thesis. By arrangement. 10 units.

RURAL ECONOMICS

Preparatory

Rural Economics 1—Economic Conditions of the Philippines. First and second semesters. 4 units. (1)

¹ Credited as 10 units for students in former curricula.

For undergraduates

- Rural Economics 2—Agricultural Economics. First and second semesters. 6 units. (a/2)
- Rural Economics 3—Farm Accounting. First and second semesters. 4 units. (b/3)
- Rural Economics 4—Rural Co-operation and Credit. First semester. 5 units. (4)
- Rural Economics 5—Commerce of Sugar. Second semester. 3 units. (5, 2 units)
- Rural Economics 99—Special Problems. By arrangement. 1 to 6 units. (IX/9/109)
- Rural Economics 100—Undergraduate Thesis. By arrangement. 10 units. (X/10)

RURAL ENGINEERING

Preparatory

- Mathematics 1—Elementary Algebra. First and second semesters. 10 units. (I/1)
- Mathematics 2—Plane Geometry. First and second semesters. 10 units. (II/2)
- Mathematics 3—Advanced Algebra. First semester. 5 units. (IIIa/3)
- Mathematics 4—Advanced Algebra Review. For high school graduates deficient in algebra. Second semester. 2 units. (5a)
- Physics 1—Elementary Physics.¹ First and second semesters. 6 units. (Ia/1a, 5 units)

For undergraduates

- Mathematics 5—Trigonometry. Second semester. 3 units. (IVb/4)
- Mathematics 6—Solid Geometry. Summer. 5 units. (6)
- Mathematics 7—Applied Agricultural Mathematics. Second semester. 5 units. (7)
- Mathematics 8—Descriptive Geometry. Summer. 4 units.
- Physics 2—General Physics.¹ Second semester. 5 units. (Ib/2)
- Rural Engineering 1a—Farm Mechanics. First semester. 4 units.² (I' 1)
- Rural Engineering 1b—Farm Machinery. Second semester. 3 units.² (I/1)
- Rural Engineering 1c—Surveying. Saturday mornings of second semester or summer. 1 unit.² (I/1)
- Rural Engineering 2—Irrigation and Drainage. First and second semesters. 10 units.
- Rural Engineering 3—Advanced Rural Engineering. First and second semesters. 10 units. (2)
- Rural Engineering 4—Dynamics. First semester. 5 units. (3)
- Rural Engineering 5—Sugar Machinery. Second semester. 5 units. (4)
- Rural Engineering 99—Special Problems. By arrangement. 1 to 6 units. (IX/9/109)
- Rural Engineering 100—Undergraduate Thesis. By arrangement. 10 units. (X/10)

Informal subjects for undergraduates

- Farm Experience B—Carpentry. Summer. Informal credit. (Carpentry)
- Farm Experience C—Blacksmithing. Summer. Informal credit. (Blacksmithing)

¹ Given together as Physics 1 + 2, 10 units, 1922-23.

² Credited together as 10 units for students in former curricula.

INDEX

VOLUME X

AUGUST, 1921, TO MAY, 1922.

A

- Abaca, *see* *Musa textilis*; baling, 280; care of the plantation, 277; compensation of strippers, 279; cultivation and preparation of fiber in Davao, 273; establishment of the plantation, 274; extraction of fiber, 278; harvesting, 277; stripping apparatus, 278
- Abelmoschus esculentus, 9, 322, 395
- ABESAMIS, AMBROSIO P., effect of time of planting on growth and yield of a lowland rice in Peñaranda, Nueva Ecija, and on the College Farm, 381
- Abutilon moth, *see* *Cosmophila erosa*
- Acalypha boehmeroides, 393
- Acanthocoris flavipes, 32
- Acanthoscelides obtectus, 35
- Acherontia lachesis, 26, 31
- Achras sapota, 9
- Acontia transversa, 322
- Acridiidae, 17, 19, 27
- Additions to Philippine and Malayan technical bibliography, 363
- Adoretus ranunculus, 30; luridus, 30; umbrosus, 33
- ADRIANO, FELIPE, notes on, 86
- Ægus acuminatus, 18
- Æolesthes induta, 33
- AGATI, JULIAN, abstract by, 405; banana stem and fruit rot, 411
- Agave cantula, 10, 322
- Ageratum conyzoides, 393
- Agestrata luzonica, 27
- Agnia clara, 33
- Agrilus occipitalis, 16
- Agromyza destructor, 21 ff, 329
- Agromyzidae, 21 ff, 329
- Agrotis c-nigrum, 12 ff.
- ALDABA, VICENTE C., the cultivation of abaca and preparation of its fiber in Davao, 273
- ALDABA, VICTOR C., the pollination of coconut, 195
- Ajonjoli, 31
- Aleurites moluccana, 10
- Aleurodicus destructor, 18
- Aleurodidae, 18
- Algodon, *see* *Gossypium*
- Alligator pear, *see* *Persea americana*
- Allium cepa, 10
- Allium sativum, 10
- Allodape mindanaonis, 212
- Alphitobius piceus, 27 ff.
- Amathusia phidippus, 17
- Amorphoidea lata, 22
- Ananas sativus, 10
- Anacardium occidentale, 10
- Andropogon sorghum, 10, 322
- Amino acids, 45
- Anona muricata, 11, 322; reticulata, 11, 322; squamosa, 12, 323
- Anobiidae, 35
- Anonas, *see* *Anona reticulata*
- Anoplocnemis phasiana, 23
- Anthraxnose, cotton, 353
- Anthribidae, 35
- Antidesma bunius, 12
- Antonina zonata, 14
- Aparceros, *see* share tenants
- Aphididae, 12 ff.
- Aphis brassicae, 14; gossypii, 14 ff; sacchari, 31; rice-root, *see* *Dryopeia hirsuta*; sugar-cane, *see* *sacchari*; sugar cane woolly, *see* *Oregma lanigera*
- Apio, *see* *Apium graveolens*
- Apis indica, 200
- Apium graveolens, 12
- Achæa melicerte, 303
- Arachis hypogæa, 12, 323, 393, 395
- Aræocerus fasciculatus, 35
- Arctiidae, 9 ff., 329
- Areca catechu, 13, 323
- Arenga pinnata, 12, 323
- Argina cribraria, 19
- Army worm, *see* *Leucania unipuncta*
- ARON, HANS, AND HOCSON, F. cited, 454
- Arrendatarios, *see* rent tenants
- Arthrocnodax copræ, 35
- Artocarpus communis, 13, 323; integra, 13
- ASHCRAFT, JAMES B., a study of the normal variation in frequency of pulse, respiration, and temperature of the carabao, 283
- ASHTON, ————notes on, 38
- Asiatic palm weevil, *see* *Rhynchophorus ferrugineus*

- Asparagus bean, *see* *Psophocarpus tetragonolobus*
 Aspidiotus coryphæ, 19; cydoniæ, 10; destructor, 15; rapax, 17; translucens, 10 ff.
 Aspidistra scale, *see* *Hemichionaspis aspidistra*
 Aspidomorpha fusconotatus, 326; miliaris, 23
 Aso, K., and BAHADUR, R., cited, 319
 Asterolecanium bambusæ, 14
 ASUNCIÓN, S., notes on, 85; 175
 Ates, *see* *Anona squamosa*
 Atis moth borer, *see* *Heterographis bengalensis*
 Atlas beetle, *see* *Chalcosoma atlas*; moth, *see* *Attacus atlas*
 Atractomorpha psittacina, 27, 31
 Attacus atlas, 12, 24, 321, 327; cynthia, 15; ricini, 25
 Aulacaspis rosæ, 30
 Aulacophora coffeæ, 16
 Auto-irrigators, 467
 Avocado, *see* *Persea americana*
- B**
- BABCOCK, E. B., and CLAUSEN, R. E., cited, 243, 251
 Bacillus solanacearum, 303, 393
 BACON, R. F., cited, 73
 Bacterium solanacearum, 393 ff.; symptoms, 396
 BAHADUR, R., *see* Aso, K., and BAHADUR, R.
 BAKER, CHARLES FULLER, additions to Philippine and Malayan technical bibliography, 363; the building of a college, 1; mentioned, 9, 106, 189, 211, 299, 322; notes on 7, 37, 260; plant breeding in the tropics, 271
 BALLOU, H. A., cited, 368
 Bamboo, *see* *Bambusa*
 Bambusa, 13, 323
 Banana, *see* *Musa sapientum*; leaf roller, *see* *Erionota thrax*; notes on effect on banana of premature appearance of inflorescence, 441; premature inflorescence, 299; stem and fruit rot, 411; rot, *see* *Glebosporium musarum*; weevil, *see* *Cosmopolites sordidus*
 Barangay, *see* hamlet
 BARRETT, —, cited, 45
 Batad, *see* *Andropogon sorghum*
 BATEMAN, —, cited, 451
 Batocera albofasciata, 16, 323; numitor, 21
 Bauang, *see* *Allium sativum*
 Bean fly, *see* *Agromyza destructor*
 Beet, *see* *Beta vulgaris*
 Beetle, atlas, *see* *Chalcosoma atlas*; cigarette, *see* *Lasioderma serricornis*; confused flour, *see* *Tribolium confusum*; drug store, *see* *Sitodrepa panicea*; saw-toothed grain, *see* *Silvanus surinamensis*; Luzon tortoise-shell, *see* *Lacoptera luzonica*
 BENTON, G. P., notes on, 125, 259
 Beri-beri, *see* polyneuritis
 Berkshire hogs, *see* hogs, Berkshire
 BERNARDO, FRANCISCO, mentioned, 216
 Beta vulgaris, 14
 Betel-nut palm, *see* *Areca catechu*
 Betel pepper, *see* *Piper betle*
 BEYERSDORFER, P., cited, 59
 BEZZI, M., mentioned, 322
 Bignay, *see* *Antidesma buniis*
 Biological study of copra meal, a, 45
 Black Araucaria scale, *see* *Chrysomphalus rossi*
 Black citrus aphid, *see* *Toxoptera aurantii*
 Black parlatoria, 17
 Black scale, *see* *Saissetia oleæ*
 Blumea balsamifera, 393
 Boboy, *see* *Eriodendron anfractuosum*
 BODMER, R., cited, 56
 Bostrychidæ, 13, 21, 24, 323
 Bostrychopsis parallela, 323
 BOYCE, W. D., cited, 145
 Brassica, 14
 Breadfruit, *see* *Artocarpus communis*
 Breeding, of rice, 93; of sugar cane, 211; of sweet potato, 177; plant, in the Philippines, instruction and investigation in, 105
 BRENTON, THADDEUS R., notes on, 39, 126
 BRILL, H. C., and THURLOW, L. W., cited, 80
 Brixiodes carinatus, 31
 Broadcasting and drilling upland rice by native method and by modern machinery, abstract, 304
 Bronthipsa froggatti, 17, 322
 BROWN, WILLIAM H., *see* WEST, AUGUSTUS P., and BROWN, WILLIAM H.
 BROWNE, C. A., cited, 57, 58
 Bruchidæ, 35
 Bruchus chinensis, 35; quadrimaculatus, 35
 BRYAN, MARY K., cited, 394
 Bud hispa, *see* *Bronthipsa froggatti*
 Building of a college, the, 1
 Bulac, *see* *Gossypium* spp.
 Buli, *see* *Corypha elata*
 BULL, C. P., *see* OLSON, P. G., BULL, C. P., and HAYES, H. K.
 Bunga, *see* *Areca catechu*; weevil, *see* *Rhabdoenemis lineaticollis*
 Buprestidæ, 16, 33
 Buri, *see* *Corypha elata*
 BUTLER, E. J., cited, 331
 BUTTERFIELD, —, notes on, 260
 BAYBAY, DOMINGO S., storage of some root crops and other perishable farm products, 423

C

- Cabbage, *see* Brassica; aphid, *see* Aphis brassicae
- Cabo negro, *see* Arenga pinnata
- Cacao, *see* Theobroma cacao
- Cadamustus typicus, 17, 26
- Cadelle, *see* Tenebrioides mauritanicus
- Cafe, *see* Coffea
- Caguio, *see* Cajanus cajan
- Cahel fruit fly, *see* Monocrostichus citricola
- Cajanus cajan, 15
- Calabaza, *see* Cucurbita maxima
- Calamismis, *see* Psophocarpus tetragonolobus
- Calamus spp., 15
- Calandra granaria, 35; oryzae, 35; sordida, 367
- Calandridae, 13 ff., 325
- Calcium nitrate, 314
- Callispa cumingi, 323; flavescens, 14
- Caloclytus annularis, 14
- Calogramma festiva, 10
- Camote, *see* Ipomoea batatas
- Camoteng-cahoy, *see* Manihot utilissima
- Canangium odoratum, 15, 324
- Canavalia spp., 15, 321, 324; gladiata, 395
- Candle nut, *see* Aleurites moluccana
- Caong, *see* Arenga pinnata
- CAPINPIN, JOSÉ M., mentioned, 189, 217; abstract by, 255
- Capsicum annum, 393
- Capsidae, 12, 16, 33, 329
- Carabao, normal variation in pulse, respiration and temperature, 283
- CARANDANG, ATANACIO T., cultural study of different varieties of tañgan-tañgan with determination of oil content, abstract, 303
- CARAY, ELIAS M., the chemical composition of copra meal with special reference to the nature of its carbohydrates, 55
- Carica papaya, 15
- CARLIER, A., cited, 55
- Carpophilus foveicollis, 35
- Carrot, *see* Daucus carota
- CARVER, G. W., cited, 424
- Cashew, *see* Anacardium occidentale
- Casoy, *see* Anacardium occidentale
- Cassava, *see* Manihot utilissima; flour, 74; industrial alcohol from, 75; starch from, 73; cost of production of starch, 73; tubers, storage, 425; variety test of cassava based on production, 255
- Castilloa elastica, 16
- Castilloa rubber tree, *see* Castilloa elastica
- Castor bean, 397
- Castor oil plant, *see* Ricinus communis
- Castor silk worm, *see* Attacus ricini
- Catachrysops cnejus, 327, 328
- CATALAN, NEMESIO, notes on, 86, 262
- CATHCART, CHARLES S., cited, 55
- Catullia subtestacea, 31
- Caturay, *see* Sesbania grandiflora
- Cebolla, *see* Allium cepa
- Cecidomyiidae, 11, 35
- Celery, *see* Apium graveolens
- Century plant, *see* Agave cantula
- CENDAÑA, SILVERIO M., abstract by, 169; the banana weevil, 367
- Cerambycidae, 14 ff., 323, 328
- Cercopidae, 31
- Cercospora apii, 349; beticola, 349
- Ceroplastes cajani, 29; rubens, 328
- Chalcosoma atlas, 17
- Chemical composition of copra meal with special reference to the nature of its carbohydrates, the, 55
- Chemistry and agriculture, 41
- Chemistry, agricultural, 113; biological, 113, industrial, 113
- CHEVROLAT, A., cited, 367
- Chicharo, *see* Pisum sativum
- Chico, *see* Achras sapota
- Chicos, storage, 425 ff., 433
- Chinese imperial spring plowing, the, 407
- CHICO, J. T., notes on, 85
- Chloridea assulta, 26; obsoleta, 9 ff.
- Chocolate, *see* Theobroma cacao
- Cholera, hog, at the College of Agriculture, 347
- Chrysanthemum coronarium, 395
- Chrysochroa bicolor, 33; fulminans, 33
- Chrysomelidae, 9 ff., 323, 324
- Chrysomphalus aonidum, 11 ff., 323; aurantii, 10 ff.; pedroniformis, 21, 34; rossi, 13
- Chunra niveosparsa, 24
- CHURCH, JOHN W., cited, 423
- Cicindelidae, 18
- Cinnamomum camphora, 324
- Citrullus vulgaris, 16
- Citrus spp., 16, 324
- Citrus leaf miner, *see* Phyllocnistis citrella
- Citrus locust, *see* Cyrtacanthacris graminea
- CLARK, CHARLES F., cited, 93
- CLAUSEN, R. E., *see* BABCOCK, E. B., AND CLAUSEN, R. E.
- CLEMENTE, LEOPOLDO S., notes on, 127
- Cleridae, 35
- Cletus bipunctatus, 30
- Climatic conditions, second type, 382; third type, 382
- COBB, N. A., cited, 411
- COCANOUER, J. A., notes on, 445
- Coccidae, 10 ff., 322 ff.
- Coccinellidae, 24, 32, 329
- Coccus elongatus, 11, 323, 324; hesperidum, 326; mangiferae, 18; viridis, 10 ff.
- Coccotrypes graniceps, 33
- Coco, *see* Cocos nucifera

- Coconut, *see* *Cocos nucifera*; leaf miner, *see* *Promecotheca cumingi*; skipper, *see* *Padraona chrysozona*; nymphalid, *see* *Amathusia phidippus*; slug caterpillar, *see* *Thosea cinereamarginata*; white fly, *see* *Aleurodicus destructor*; holdings, 157; coconut terms, 157; contracts, 157, 160, 164; corn terms, 160; land ownership, 155, 163; length of tenancy, 154, 163; rice terms, 157; secondary crops, 153; tenancy, 145
- Cocos nucifera*, 17, 324; flowers, 197; pollinating agents, 200; pollination, 195 ff.
- Coffea* spp., 18, 325
- Coffee, *see* *Coffea*; scale, *see* *Coccus viridis*
- COHEN, B., and MENDEL, L. B., cited, 350
- Coleoptera, 9 ff., 323 ff.
- COLLADO, ISIDORO R., cited, 96
- Colletotrichum gossypii*, 253
- College of Agriculture, administrative officers, 481; curricula, 489; faculty, 481; general information, 485; regulations relative to curricula, 494; subjects of the curricula, 497
- COLLINS, G. N., cited, 95
- Collyris albitarsis*, 18
- Colo, *see* *Artocarpus communis*
- Colocasia esculentum*, 19
- Comparative culture of upland and lowland rice with special reference to cost of production and distribution of income, abstract, 443
- Comparative tests of rice seeds from the principal and poorest culms in individual plants, 243
- Common screw pine, *see* *Pandanus tectorius*
- CONCEPCION, —, cited, 453
- CONNER, C. M., cited, 95
- Contarinia salta*, 11
- Contributions to chemical science, Philippine, 115
- Control of soil moisture by means of auto-irrigators, 467
- COOKE, C. M., cited, 422; MELVILLE, THURSTON, cited, 411
- COPELAND, E. B., cited, 73
- Copra meal, biological study of, 45; carbohydrates, 57 ff.; chemical composition, 55; antiscorbutic property of, 50
- Coptosoma cincta*, 324; cribrarium, 23, 33
- Corchorus olitorius*, 19
- Cercospora batatae*, 254
- Coreidæ, 11 ff., 327
- Correlation of rice characters, 93
- Corn, *see* *Zea mays*; average yield per hectare, 289; native yellow flint, pedigree selection, 289; secondary crop, 153; borer, European, 32; earworm, *see* *Chloridea obsoleta*
- Corrodentia, 13 ff.
- Corypha elata*, 19, 325
- Cosmophila erosa*, 22, 34, 325; *sabulifera*, 9, 19
- Cosmopolites sordidus*, 25, 26, 267, 368; control, 373; habits, 369; injury, 369, 370; life history, 372; natural enemies, 372
- Cotton, *see* *Gossypium* spp.; anthracnose, 253; bollworm, *see* *Chloridea obsoleta*; stainer, *see* *Dysdercus megalopygus*
- Cowpea, *see* *Vigna* spp.; *Sclerotium* on, 337
- CRAIG, JOHN A., cited, 144
- CRANFIELD, H. T., cited, 55
- Cricket, African mole, *see* *Gryllotalpa africana*
- Crocidolomia binotalis*, 14, 29
- Crotalaria retusa*, 19
- Croton glandulosus* var. *septrionalis*, 393
- Cruchus dominicanus*, 35
- Cryptorrhynchus mangiferae*, 24
- Cucujidæ, 35
- Cucumber, *see* *Cucumis sativus*
- Cucumis melo*, 19; *sativus*, 20
- Cucurbita maxima*, 20
- Cultivation of abaca and preparation of its fiber in Davao, 273
- Cultural study of different varieties of tañgan-tañgan with determination of oil content, abstract, 303
- Cureulionidæ, 10 ff.
- Custard apple, *see* *Anona reticulata*
- CUZNER, HAROLD C., notes on, 175; what is agricultural engineering, 130
- Cyclopelta obscura*, 18
- Cylas formicarius* (?), 23
- Cynthia moth, *see* *Attacus cynthia*
- Cyrtacanthacris graminea*, 17
- Cystine, 45
- Czechoslovakia sugar station, 43

D

- Dactylispa bipartita*, 14; *cladophora*, 14; *infusata*, 14
- Dacus caudatus*, 19; *cucurbitæ*, 15 ff., 326; *ferrugineus*, 21 ff., 321, 324
- DAIKUHARA, G., 316; and IMASEKI, cited, 317
- DANIEL, L., cited, 475
- DASTUR, JEHangir FARDUNGI, cited, 411
- Datura stramonium*, 394
- Daucus carota*, 20
- Davao, abaca cultivation in, 273; soil and climate, 274
- DAVID, PEDRO, abstract, 443
- DAVIS, MARGUERITE, *see* McCOLLUM, E. V., AND DAVIS, MARGUERITE
- Dayap, *see* Citrus
- Death-head moth, *see* *Acherontia lachesis*
- Deficiency diseases, 451
- Deiopia pulchella*, 30, 34
- DERECHO, ANTONIO, a biological study of copra meal, 45

Dermestes vulpinus, 35
Dermestidae, 35
 Diamond-back moth, *see* *Plutella maculipennis*
Diatraea sp., 30
Dichocrosis punctiferalis, 11 ff., 29
Dicranotropis saccharieida, 31
 Diet, Filipino, 453 ff.
Dihammus fistulator, 321, 328
Dindymus rubiginosus, 18
Dinoderus brevis, 13; *minutus*, 13
Diocalandra frumenti, 17
Dioscorea alata, 20
Diospyros kaki, 20
Diplodia, 423
 Diptera, 11 ff., 324
 Diseases, deficiency, 451
 DODEN, HANS, mentioned, 214
Dolichos lablab, 21
Drosicha townsendi, 22, 325, 328
 DRUMMOND, J. C., *see* HALLIBURTON, W. D., and DRUMMOND, J. C.
Dryopeia hirsuta, 27
 DURHAM, S. B., cited, 135
 DUMAS, —, mentioned, 213
Dysdercus megalopygus, 9, 10, 15, 22; *pæcilus*, 22

E

Editorials, 1, 41, 89, 129, 271, 361
 Effect of season upon the culture of roselle, abstract, 405
 Effect of time of planting on growth and yield of a lowland rice in Peñaranda, Nueva Ecija, and on the College Farm, 381
 Effect on banana fruit of premature appearance of the inflorescence, 299; note on, 441
 Effects of fertilizers added to soil on the growth of roselle plants and production of fiber, the, abstract, 350
 Effects of salts added to the soil in pots upon the growth of roselle plants and production of fiber, abstract, 443
 Eggplant, *see* *Solanum melongena*
 ELJKMAN, C., cited, 448
Elæis guineensis, 325
 ELAYDA, A., cited, 290; INOCENCIO mentioned, 298; 439; notes on, 259
 ELY, RICHARD T., ET AL., cited, 145
Empoasca flavescens, 22, 328
Encomienda, 146
 Endive, storage, 426, 434 ff.
Eoporis elegans, 33
Eosaccharissa pulchra, 17
Epepeotes luscus, 16, 24, 33
Ephestia cautella, 35; *kuehniella*, 35
Epipedocera lunata, 33

Epilachna dodecastigma, 32; *pusillanima*, 32, 326; *maculata*, 329; 28-punctata, 24, 32
 Eri, *see* *Attacus ricini*
Eriodendron anfractuosum, 21
Erionota thrax, 17, 25
Erotylidae, 32
 ESPINO, R. B., cited, 196, 314; mentioned, 392, 439; mineral salt requirement of rice, 313; notes on, 38, 259, 361
 ESTALILLA, HILARION, the atis moth borer, abstract, 169
 ESTRADA, ALBERTO, abstract, 304
Etiella zinckenella, 28
Euchromia elegantissima, 23
Euclea albata, 24; *capito*, 24
Eugenia malaccensis, 21, 325
Eugithopus plagiatus, 15
Eumetopina flavipes, 31
Euphalerus citri, 16
Euproctis austriaca, 10
Eupterota fabia, 24, 325
 European florinia, *see* *Florinia floriniæ*
 Europe's youngest republic establishes a sugar station, 43
Eurydactylus sexspinosus, 33
Eurydema pulchra, 14
Eutermes gracilis, 13; *luzonicus*, 14 ff.
Euxoa segetis, 14, 19, 21, 23
 EWING, E. C., cited, 95
 EWING, P. V., AND SPENCE, E. R., cited, 55

F

FAWCETT, WILLIAM, cited, 411
 FELLO, AGAPITO, notes on, 446
 FERRIS, G. F., mentioned, 322
 Fertilization, 313; of roselle, 350
 Fertilizers, Philippine, 113
 Fiji disease, 216
 FINGERLING, G., cited, 55
 FINKS, A. J., *see* JOHNS, O. O., FINKS, A. J., AND PAUL, M. S.
Florinia floriniæ, 13 ff.
 Fishes, Philippine, 113
 FLETCHER T. BAINDRIGE, cited, 367
 FLEUTIAUX, E., cited, 367
 Florida red scale, *see* *Chrysomphalus aonidum*
 Flower of coconut, 195; of sweet potato, 177; of banana, 299, 441
 Food problems, 447
 Foreign sugar market, the, 271
 Four-spotted coconut weevil, *see* *Diocalandra frumenti*
 FRANCISCO, SIXTO A., *see* SCHWARTZ, BENJAMIN, TUBANGUI, MARCOS, A., AND FRANCISCO, SIXTO A.
 FRANK, A., *see* FREISE, E., GOLDSCHMIDT, M., AND FRANK, A.
 FRAZER, H., AND STANTON, A. T., cited, 448

FREISE, E., GOLDSCHMIDT, M., AND FRANK,
A., cited, 451
FROGGATT, W. W., cited, 368
Fulgoridæ, 11, 17, 18, 322, 325
FUNK, C., cited, 448
Furcaspis hæmatochroa, 18

G

Gabi, *see* Colocasia esculentum
Gabi tubers, storage, 424 ff.
GALPIN, C. J., AND HOAG, EMILY F., cited, 168
Garcinia mangostana, 325
Garden pea, Sclerotium on, 337
Gardenia, 321
Garlic, *see* Allium sativum
GARNER, W. W., WOLF, F. A., AND MOSS,
E. G., cited, 394
GAY, CARL W., cited, 137
Gelechiidæ, 21, 26
General pests, 34
GERMAR, E. F., cited, 367
Gifts to the college, 3
Gloeosporium musarum, 411; economic importance, 411; morphology, 416; physiology, 417; spore dissemination, 318; symptoms, 413; taxonomy, 418
Glomerella gossypii, 253
Glycine max, 325, 395
Gnaphalocrosis medinalis, 27, 34
Gnoma luzonica, 4
GOCO, LORENZO, pedigree selection with native yellow flint corn, 289
GODFREY, G. H., *see* SMITH, E. F., AND GODFREY, G. H.
GOLDENWEISER, E. A., *see* SPILLMAN, W. J., AND GOLDENWEISER, E. A.
GOLDSCHMIDT, M., *see* FREISE, E., GOLDSCHMIDT, M., AND FRANK, A.
Gonocephalum acutangulum, 26, 30
GONZALEZ, B. M., hog cholera at the College of Agriculture, 347; mentioned, 54; JOAQUIN notes on, 261
GOSECO, ANDRES, notes on, 261
Gossypium spp., 21, 325
Grape vine, *see* Vitis vinifera
GRAY, L. C., AND TURNER, HOWARD A., cited, 168
Greedy scale, *see* Aspidiotus rapax
Green plant bug, *see* Nezara viridula
Green tobacco aphid, *see* Myzus persicæ
Gryllidæ, 31
Gryllotalpa africana, 27, 328
Gryllotalpidæ, 328
Gryllus, 94
GUTIERREZ, MARIANO E., cited, 93
Guava, *see* Psidium guajava
Guanabano, *see* Anona muricata

GUEVARA, CAMILO C., effects of salts added to the soil in pots upon the growth of roselle plants and production of fiber, abstract, 443
Guinea grass, *see* Panicum
GUTERMAN, ARTHUR, quoted, 352
Gumbo, *see* Abelmoschus esculentus

H

Haba, *see* Canavalia
HABALUYAS, RAMÓN K., notes on, 86
HADLEY, FREDERIC B., cited, 144
HALLIBURTON, W. D., AND DRUMMOND, J. C., cited, 45
Halticus minutus, 12
Hamlet, 146
HANSEN, *see* HENRIQUES AND HANSEN
HARRISON, J. B., cited, 317
HARRISON, W. H., cited, 317
HARDEN, A., AND ZILVA, S. S., cited, 52
HART, E. B., STEENBOCK, H., AND HOPPER, C. A., cited, 454
HARTLEN, C. P., cited, 289
Hawaiian beet webworm, *see* Hymenia fascialis
HAWK, PHILIP B., cited, 57
HAWKINS, LON A., cited 485
HAYES, H. K., *see* OLSON, P. G., BULL, C. P., AND HAYES, H. K.
HELBERO, MARCOS, mentioned, 207
Heliothrips rubrocinctus, 10, 19
Helopeltis antonii, 329; bakeri, 33; collaris, 16
Hemichionaspis aspidistræ, 10 ff.; townsendi, 22, 326
Hemiptera 9 ff., 322 ff.
Hemispherical scale, *see* Saissetia hemispherica
HENRIQUES AND HANSEN, cited, 450
HERBERT, D. A., notes, on, 445
Heronax maculipennis, 17, 19
HERRICK, R. F., cited, 76
Hesperidæ, 13, 17, 25
HESS, A. F., AND UNGER, L. J., cited, 50
HESTER, EVETT D., AND MIÑANO, GERONIMO, tenancy on coconut holdings in the municipality of Looc, province of Romblon, 145; notes on, 38
Heterobostrychus æqualis, 13, 21
Heterographis bengalella, 11, 169
Hevea brasiliensis, 22
Hibiscus sabdariffa, 22, 326, 350, 395
HIGGINS, J. E., mentioned, 299, 405; notes on, 37
Hilda breviceps, 11
HILGARD, —, mentioned, 468
HILL, PERCY A., AND MOE, KILMER, cited, 93
HIND, —, mentioned, 214
Hippotion celerio, 19, 21
Histidine, 45

HITCHCOCK, A. S., notes on, 37
 HOAG, EMILY F., *see* GALPIN, C. J., AND HOAG, EMILY F.
 HOCSON, F., *see* ARON, HANS, AND HOCSON, F.
 Hog cholera at the College of Agriculture, 347; symptoms, 347
 HOGAN, A. J., cited, 45
 Hogs, Berkshire, 347
 Holotrichia vidua, 30
 HONING, —, mentioned, 393
 Hookworm in students at Los Baños, 90
 HOPKINS, F. G., cited, 447, 454
 HOPPERT, C. A., *see* HART, E. B., STEENBOCK, M., AND HOPPERT, C. A.
 Horse, Philippine, observations on, 135
 Host index of insects injurious to Philippine crops, I, 9; II, 321
 House fly, *see* Musca domestica
 HUME, A. N., cited, 289
 HUNGER, T. W. F., cited, 195
 Hyarias metarhoda, 9 ff., 329
 Hydrolysis arginine, 45
 Hymenia fascialis, 14 ff.
 Hypolimnas misippus, 21, 32

I

Icerya aegyptiaca, 17, 25; jacobsoni, 29; seychellarum, 17, 20, 322, 323
 Idioscopus clypealis, 24
 Ilang-ilang, *see* Canangium odoratum
 IMASEKI, K., *see* DAIKUHARA AND IMASEKI
 Impatiens balsamina, 393
 Incidence of hookworm infestation in students at Los Baños, 90
 Indian meal moth, *see* Plodia interpunctella
 Indigo, *see* Indigofera spp.
 Indigofera spp., 23
 Indigophora erecta, 393
 Industrial alcohol from cassava, 75
 Industries, Philippine, 114
 Insects injurious to Philippine crops, 9, 321
 Instruction and investigation in plant breeding in the Philippines, 105
 Investigation of conditions affecting the quantitative determination of reducing sugars by Fehling's solution and the elimination of certain errors involved in the current methods, 69
 Ipidæ, 33, 324, 329
 Ipomœa batatas, 23, 326, 395
 Irrigation, 467

J

JACOBSON, H. O., cited, 95, 101, 103
 Jak fruit, *see* Artocarpus integra
 JANSEN, B. C. P., cited, 45
 Jasminum, 321
 Jassidæ, 22, 24, 27, 328
 JEPSON, F. P., cited, 367

JOHNS, O. O., FINKS, A. J., AND PAUL, M. S., cited, 45, 47, 55
 JOHNSON, O. R., cited, 145
 JONES, W. J., JR., ET AL., cited, 55
 JURADO, M. C., *see* TRELEASE, SAM F., AND JURADO, M. C.
 Jute, *see* Corchorus olitorius

K

Kapok, *see* Eriodendron anfractuosum
 KELLEY, W. P., cited, 317, 318
 KELLNER, O., cited, 315
 KENNEDY, C., *see* MCCOLLUM, E. V., AND KENNEDY, C.
 Keratomalacia, 451
 KING, WILFORD I., cited, 100
 KNOWLES, C., cited, 367
 KOKETSU, R., *see* LIVINGSTON, B. E., AND KOKETSU, R.
 Koo, M. F., notes on, 85
 KOPKE, E. W., notes on, 85
 KOSTER, L. P., notes on, 38
 KRAUSS, F. G., cited, 317

L

LABAYEN, SEGUNDO, notes on, 86
 Lablab bean, *see* Dolichos lablab
 LABRADOR, ANSELMO F., cited, 96; mentioned, 243
 Laccoptera luzonica, 23
 Lactuca sativa, 23, 468
 Læmotmetus rhizophagoides, 35
 LAIRD, C. N., notes on, 85
 Lanca, *see* Artocarpus integra
 Lasiocampidæ, 24, 325
 Lasioderma serricorne, 35
 Leaf-bud hispa, *see* Bronthispa froggatti
 Leaf spot of sweet potato, 254
 Lechuga, *see* Lactuca sativa
 LEIGHTY, C. E., *see* LOVE, H. H., AND LEIGHTY, C. E.
 LEIGHTY, CLYDE E., cited, 94
 Lemons, storage, 425
 LEONARD, IRVING A., notes on, 175, 445
 LEONCINI, GIOVANNI, cited, 64
 Lettuce, *see* Lactuca sativa
 Leptocoris acuta, 11, 27, 30, 388
 Leptoglossus membraneus, 20, 327
 Lepidoptera, 9 ff., 322
 Lepidosaphes lasiantha, 324; mcgregori, 18; rubrovittatus, 21; unicolor, 18
 Leucania unipuncta, 11, 14
 Lilik, 304
 Lima bean, *see* Phaseolus; pod borer, *see* Etiella zinckenella
 Limacodidæ, 17
 Limon, *see* Citrus spp.
 LINDSEY, J. B., cited, 55

Liogryllus bimaculatus, 31
 List of Philippine contributions to chemical science, 115
 LIVINGSTON, B. E., cited, 467; AND KOKETSU, R., cited, 467
 LIZASO, JUAN, observations on the Philippine horse, 135
 LLENADO, AGUSTIN, notes on, 175
 Locust, *see* *Phaneroptera furcifera*
 Locustidæ, 323, 324
 LONTOC, A., cited, 291
 LOPEZ, VICENTE, notes on, 260
Lophocateres pusillus, 35
 LOVE, H. H., cited, 95; AND LEIGHTY, C. E., cited, 94
 Loyalty Day resolutions, 353
 Lucanidæ, 18
 Lucban, *see* *Citrus* spp.
Lucilia, 200
 Luffa spp., 326
 Lumbang, *see* *Aleurites moluccana*
Luperomorpha serricornis, 24, 324, 328
 LUTZ, FRANK E., cited, 94
 Lycænidæ, 327, 328
Lycopersicum cerasiforme, 393; *esculentum*, 23, 326
 Lygæidæ, 22
Lymantria lunata, 13
Lymantriidæ, 10 ff.
 Lysine, 45

M

MACASAET, JR., VALENTIN, cited, 391
 MACKIE, D. B., cited, 135, 367, 368
 Macopa, *see* *Eugenia malaccensis*
 Magnesium sulphate, 314
 Maguey, *see* *Agave cantula* (cantala, according to Merrill)
 Maize, *see* *Zea mays*
 Malayan technical bibliography, additions to, 363
 Mandarins, *see* *Citrus* spp.
Mangifera indica, 24, 326
 Mango, *see* *Mangifera indica*; bark borer, *see* *Plocæderus ruficornis*; fruit fly, *see* *Dacus ferrugineus*; weevil, *see* *Cryptorhynchus mangiferae*
 MAÑGONON, ALEJANDRO S., cited, 59; notes on, 86
 Mangostan, *see* *Garcinia mangostana*
 Mani, *see* *Arachis hypogæa*
 Manihot utilissima, *see* cassava
 MANIO, RAMÓN V., *see* ROXAS, MANUEL L., AND MANIO, RAMÓN V.
 Manioc, *see* *Manihot utilissima*
 MARIANO, SEVERO, notes on, 175; S. J., cited, 95

MARILAO, VENERANDO, broadcasting and drilling upland rice by native method and by modern machinery, abstract, 304
 MARQUEZ, F. D., cited, 298
Martynia proboscidea, 393
 Mayas, *see* *Munia jagori*
 McCLENDON, T. F., cited, 454
 MCCOLLUM, E. V., cited, 448; AND DAVIS, MARGUERITE, cited, 46, 49; AND KENNEDY, C., cited, 450; AND OTHERS, cited, 452
 McLEAN, FORMAN T., mentioned, 392, 477; notes on, 126
 McWHORTER, FRANK P., mentioned, 477; note on "effect on banana fruit of premature appearance of the inflorescence," 441
 Mealy bug, sugar cane, *see* *Pseudococcus sacchari*
Mecopus bispinosus, 25; *hopei*, 25
 Mediterranean flour moth, *see* *Ephestia kuehniella*
Melanitis ismene, 10, 27; *leda*, 30
 Melon, *see* *Cucumis melo*; aphids, *see* *Aphis gossypii*; fly, *see* *Dacus cucurbitæ*
 MENDEL, L. B., cited, 450; *see also* COHEN, B., AND MENDEL, L. B.; *see also* OSBORNE, THOMAS B., AND MENDEL, L. B.
 MENDEL, LAFAYETTE B., *see* OSBORNE, THOMAS B., AND MENDEL, LAFAYETTE B.
 MENDIOLA, N. B., cited, 213; notes on, 38, 260, 354
 MENDIOLA, NEMESIO B., effect on banana fruit of premature appearance of the inflorescence, 299; instruction and investigation in plant breeding in the Philippines, 105; mentioned, 103, 207, 246, 251, 298, 441; two years of sweet potato breeding, 177; sugar cane breeding in the College of Agriculture, 211
Metopsilus acteus, 19
Metriona trivittata, 23
Microtermes los-banosensis, 14
 MIGULA, —, mentioned, 393
 MILLER, HUGO H., cited, 147
 MIÑANO, GERONIMO, *see* HESTER, EVETT D., AND MIÑANO, GERONIMO
 Mineral salt requirement of rice, 313
 MIRASOL, —, mentioned, 259; JOSÉ, J., the year's enrollment, 89
 Modern conception of nutrition and some of our food problems, the, 447
 MOE, KILMER, *see* HILL, PERCY A., AND MOE, KILMER
 Molhant process, 80
 Mollusks, Philippine, 113
Molucca coconut hispid, *see* *Pleisispa reichei*
Monacrostichus citricola, 16
Monochirus mæstus, 14
Monohammus fistulator, 15, 18, 21

Monolepta bifasciata, 321, 326
 Monopotassium phosphate, 314
 MORADA, JULIAN K., variety test of upland rice, abstract, 256
 Moral, *see* Morus alba
 Momordica charantia, 25, 327
 Mortality, infant, 462
 Morus alba, 25
 MOSS, E. G., *see* GARNER, W. W., WOLF, F. A., AND MOSS, E. G.
 Moth, atlas, *see* Attacus atlas
 Mountain pepper, Sclerotium on, 337
 MOZNETTE, G. F., cited, 368
 Mucuna sp., 393
 Mulberry, *see* Morus alba
 Mungo, *see* Phaseolus
 Munia jadori, 388
 Musa sapientum, 25
 Musa textilis, 26, 321, 327, 367
 Musca domestica, 200
 Mustard, *see* Brassica
 Mycosphaerella fragariae, 349
 MYERS, C. H., cited, 93
 Myzus persicae 12

N

NAGAOKA, M., cited, 315
 Naranjita, *see* Citrus spp.
 NAVARRO, F., notes on, 85
 Nauphaeus linearis, 17
 Necrobia rufipes, 35
 Neolanguria filiformis, 32
 Nephrotettix apicalis, 27, 328
 Nesokaha lineata, 18; rubrinervis, 18
 NEWMAN, L. H., cited, 243, 251
 Nezara viridula, 9 ff., 324, 326
 Nicotiana, 393; tabacum, 26, 327
 Nirvana pallida, 31; philippinensis, 328
 Nisia atrovenosa, 27
 Nisotra gemella, 9
 Nitidulidæ, 35
 Nitrogen, 314
 Noctuidæ, 9 ff., 322, 325
 Nutrition, 447; essential factors, 451; historical, 447 ff.; modern conception, 451
 Nymphalidæ, 10, 17, 211
 Nymphula depunctalis, 27

O

Observations on the Philippine horse, 135
 Oil palm, *see* Elæis guineensis
 Okra, *see* Abelmoschus esculentus
 Olenecamptus bilobus, 24, 33
 OLSON, P. G., BULL, C. P., AND HAYES, H. K., cited, 95
 Onion, *see* Allium cepa
 Ophideres fullonica, 16
 Ophiura melicerte, 29

Orange dog, *see* Papilio alphenor
 Orange scale, *see* Chrysomphalus
 Oregma bambusæ, 14; lanigera, 31
 Ores, Philippine, 113
 Orgyia postica, 12, 22
 Orthoptera, 17 ff., 323
 Oryctes rhinoceros, 17, 323, 325
 Oryza sativa, 27, 93, 153, 243, 256, 304, 313, 327, 331, 332, 381, 461
 OSBORNE, T. B., AND MENDEL, L. B., cited, 46, 448, 450
 OSBORNE, THOMAS B., AND MENDEL, LAFAYETTE B., cited, 46
 Our Dean is honored, 7
 Our governors, 129
 Oxycarenus hyalinipennis, 22; lugubris, 22
 Oxya intricata, 27, 31; velox, 19, 27

P

Pachytylus migratoroides, 34
 Padraona chrysozona, 13, 17
 Palay, *see* Oryza sativa
 Pandan, *see* Pandanus tectorius
 Pandanus tectorius, 27
 Panic grass, *see* Panicum spp.
 Panicum spp., 28; maximum, 46
 Papaya, *see* Carica papaya; Sclerotium on, 338
 Papilio agamemnon, 11; alphenor, 15; rumanzovia, 16
 Papilionidæ, 11 ff.
 Passiflora, 28
 Passion flower, *see* Passiflora
 Paralecanium expansum quadratum, 18, 324
 Para rubber tree, *see* Hevea brasiliensis
 Parlatoria greeni, 18; proteus, 21; ziziphus, 17
 Parnara mathias, 327
 Parria, *see* Mormordica charantia
 Patani, *see* Phaseolus
 PAULICAN, C., cited, 290
 PAULINO, P., *see* TRELEASE, SAM F., AND PAULINO, P.
 PAUL, M. S., *see* JOHNS, O. O., FINKS, A. J., AND PAUL, M. S.
 Pea, *see* Pisum sativum
 Peanut, *see* Arachis hypogæa; Sclerotium on, 337
 PEARSON, KARL, mentioned, 100; ET AL., cited, 144
 Pechay, *see* Brassica
 Pectinophora gossypiella, 21
 Pedigree selection with native yellow flint corn, 289
 Pellagra, 452
 Pentatomidæ, 9 ff., 324
 Pepino, *see* Cucumis sativus
 Pepper, Sclerotium on, 338
 PERALTA, F. DE, cited, 97, 381; the control of soil moisture by means of auto-irrigators, 467

- Peregrinus maidis*, 34
 PEREIRA, E. DE BRAGANÇA, *Sclerotium* disease of rice, 331
Perkinsiella bakeri, 11, 328; *lineata*, 31; *vastatrix*, 31
Persea americana, 28, 321, 327
Persimmon, *see* *Diospyros kaki*
 Pests, general, 34
Phaneroptera furcifera, 322 ff.
Phaseolus spp. 28, 327
Phenacaspis inday, 18, 24, 329
Phenacoccus hirsutus, 22, 327
 Philippine and Malayan technical bibliography, entomological, 363; mycological, 365
 Philippine contributions on agricultural, biological, and industrial chemistry, 113
 Philippine horse, defects, 141, ff., observations on, 135
 Philippine orange moth, *see* *Prays citri*
 Philippine technical bibliography, additions to, 363
Phoma sabdariffæ, 405
Phathorimæa heliopa, 26
Phyllocnistis citrella, 16
Phyrrhocoridae, 10
Physalis angulata, 393; *classifolia*, 394; *philadelphia*, 394
Phytophthora infestans, 348
 PIGUING, RAFAEL M., abstract, 257
 Piña *see* *Ananas sativus*
 Pineapple, *see* *Ananas sativus*
Pinnaspis buxi, 13
Piper betle, 28
Pisum sativum, 29, 395
 Plant breeding in the Philippines, 105; in the tropics, 271
 Plant diseases found at Trinidad in December, 1921, 348
 Platano, *see* *Musa sapientum*
Pleisispa reichei, 322, 325
Plocæderus ruficornis, 24
Plodia interpunctella, 35
Pluchea indica, 393
Plusia eriosoma, 34, 327, 328
Plutella maculipennis, 14, 29
 Potato, *see* *Solanum tuberosum*
 Potassium nitrate, 315
Pouzolzia sp., 393
 Pollination of coconut, the, 195; of sweet potato, 178
 Polyneuritis, 448, 449, 451
Polymmatius boeticus, 327
 Pomelo, *see* *Citrus* spp.
 Pomelos, storage of, 425, 433 ff.
Prays citri, 16
Prionocerus cæruleipennis, 200
Prodenia litura, 12 ff.
Promecotheca eumingi, 17, 322
 PRONTO, JUAN R., abstract by, 303
Protoparce convolvuli, 23
Protopulvinaria longivalvata, 28
Proutista mæsta, 27, 31, 34, 322
Pseudomonas campestris, 348
Pseudaonidia circuliginus, 19; *trilobitiformis*, 13
Pseudococcus bromeliæ, 10, 322, 323; *filamentosus*, 11 ff.; *lilacinus*, 12 ff., 325 ff.; *sacchari*, 31; *virgatus*, 10 ff., 324 ff.
Psidium guajava, 29, 328
Psophocarpus tetragonolobus, 328, 337, 395
Psylliodes balyi, 32; *splendida*, 32
Psyllidæ, 16
Ptyelus costalis, 31
Pulvinaria polygonata, 17; *psidii*, 12, 29, 324
Puto spinosus, 12, 24, 326
Pyralidæ, 11 ff.
Pyrausta nubilalis, 28, 32, 24
Pyrrhocoridae, 9 ff.
Pyrrhoneura maculata, 18

Q

- QUISUMBING, FRANCISCO A., notes on, 39, 85, 259; Philippine contributions on agricultural, biological, and industrial chemistry, 113; AND THOMAS, A. W., investigation of conditions affecting the quantitative determination of reducing sugars by Fehling's solution and the elimination of certain errors involved in the current methods, 69

R

- Radish, *see* *Raphanus sativus*
 Radishes, storage, 425, 434 ff.
 RAMOS, FLORENTINO, comparative culture of upland and lowland rice with special reference to cost of production and distribution of income, abstract, 443
Ramularia tulasnei, 349
 Ranger, the, 129
Raphanus sativus, 29
 Rattan, *see* *Calamus* spp.
 Red banded thrips, *see* *Heliothrips rubrocinctus*
 Red-legged ham beetle, *see* *Necrobis rufipes*
 Red-rust flour beetle, *see* *Tribolium ferrugineum*
 REINKING, OTTO A., cited, 254, 331; mentioned, 421, 439; notes on, 38
 Remolacha, *see* *Beta vulgaris*
 Rent systems in Philippines, 147
 REYES, GAUDENCIO M., cited, 423; TEODORICO P., the effects of fertilizers added to soil on the growth of roselle plants and production of fiber, abstract, 350
Rhabdocnemis lineatocollis, 13, 17
 Rhinoceros beetle, *see* *Oryctes rhinoceros*

Rhodoneura intimalis, 12
 Rhynchiumatrum, 200
 Rhyncophorus ferrugineus, 17, 325
 Ricania speculum, 18, 31, 322
 Rice, *see* *Oryza sativa*; as secondary crop, 153; broadcasting and drilling upland by native method and by modern machinery, 304; comparative tests from the principal and poorest culms in individual plants of, 243; comparative culture of lowland and upland with special reference to cost of production and distribution of income, 443; deficient as cereal, 461; effect of time of planting on growth, 381; mineral salt requirements of, 313; Sclerotium disease of, 331; varieties affected by Sclerotium, disease of, 331; varieties affected by Sclerotium, 332; varieties not affected by Sclerotium, 332; variety test of upland, 256; varieties, variation and correlation of characters, 93; aphids, *see* *Tetraneura oryzae*; army worm, *see* *Spodoptera mauritia*; borer, 256; bug, *see* *Leptocoris acuta*; growing portrayed in Chinese art, 131; nymphalid, *see* *Melanitis ismene*
Ricinus communis, 29, 303, 394
 Rickets, 452
 RIETZ, HENRY L., AND SMITH, LOUIS H., cited, 94
 Riptortus fuscus, 30
 ROLDAN, EMILIANO F., *see* WELLES, COLIN G., AND ROLDAN, EMILIANO F.
 Root crops, storage, 423
 Rosa, 30
 ROSARIO, CORNELIO C., mentioned, 189
 Rose, *see* Rosa
 Roselle, *see* *Hibiscus sabdariffa*; the effects of salts added to the soil in pots upon the growth and production of fiber of, 443; effect of season upon, 405
 Ross, H. B., cited, 215; mentioned, 213
 Rot, banana, 411
 ROXAS, MANUEL L., chemistry and agriculture, 41; Europe's youngest republic establishes a sugar station, 43; mentioned, 54, 67; notes on, 260; the modern conception of nutrition and some of our food problems, 447; AND MANIO, RAMON V., industrial alcohol from cassava, 75; starch from cassava, 73
 RUEGG, S. G., cited, 43

S

Saccharomyces ellipsoideus, 76
 Saccharum officinarum, 30, 328
 SACKETT, W. G., *see* STEVENS, F. S., AND SACKETT, W. G.

Saissetia hemisphaerica, 11 ff., 322; nigra, 11 ff., 328; olea, 321, 325; triangularum, 18
 SALINAS, LEONARDO, notes on, 127, 354
 Salpiglossis sinuata, 393
 Sampaloc, *see* *Tamarindus indica*
 Sandia, *see* *Citrullus vulgaris*
 SANTOS, FRANCISCO O., cited, 45, 55, 56; notes on, 85
 Sarcophaga sp., 207
 Saturniidae, 12, 15, 24
 Scarabaeidae, 17, 27, 323, 324
 SCHAUS, WILLIAM, mentioned, 322
 SCHREINER, O., AND SKINNER, J. J., cited, 313, 314
 Schœnobia bipunctifer, 27, 30
 SCHULTZE, W., cited, 368
 SCHWARTZ, BENJAMIN, TUBANGUI, MARCOS A., FRANCISCO, SIXTO A., incidence of hookworm infestation in students at Los Baños, 90
 Sclerotium, causal organism, 338; disease of rice, 331; economic importance, 332; symptoms, 333; glumale, 331; irregulare, 331; on calamismis, 337; on cowpea, 337; on garden peas, 337; on mountain pepper, 337; on papaya, 338; on peanut, 337; on pepper, 338; on sesamum, 338; on squash, 338; on soy beans, 336; oryzae, 331 ff.
 Scurvy, 448, 451, 452
 Sebuyas, *see* *Allium cepa*
 Seedling sugar canes, 211; sweet potatoes, 177
 Seguidilla, *see* *Psophocarpus tetragonolobus*
 Selenaspidus articulatus, 17
 Sesame, *see* *Sesamum orientale*
 Sesamum indicum, 393, 395; orientale, 31; Sclerotium on, 338
 Sesbania grandiflora, 31
 Setaria italica, 31
 Setomorpha tineoides, 26
 SHAW, F. J. F., cited, 331
 SHERMAN, H. C., cited, 78, 452
 SHIVE, J. W., cited, 314
 SHIVER, F. S., cited, 424
 Shot-hole coconut weevil, *see* *Nauphaeus linearis*
 Silk cotton tree, *see* *Eriodendron anfractuosum*
 Silvanus surinamensis, 35
 Sipalus granulatus, 10
 Sirihuelas, *see* *Spondias purpurea*
 Sisal hemp, *see* *Agave cantula* (cantala, according to Merrill)
 SISON, PEDRO L., variety test of cassava based on production, abstract, 255
 Sitao, *see* *Vigna* spp.
 Sitodrepa panicea, 35
 Sitotraga cerealella, 35

- SKELTON, S., cited, 55
 SKINNER, J. J., *see* SCHREINER, O., AND SKINNER, J. J.
 SMITH, E. F., cited, 393; AND GODFREY, G. H., cited, 394
 SMITH, F., cited, 381
 SMITH, L. H., cited, 290
 SMITH, LOUIS H., *see* RIETZ, HENRY L., AND SMITH, LOUIS H.
 SMITH, P. H., cited, 55
 Synedrella nodiflora, 393
 Sodium nitrate, 316
 Soil moisture, control by means of auto-irrigators, 467
 Soils, Philippine, 113
 Solanaceous wilt in the Philippine Islands, 393
 Solanum melongena, 32, 321, 328; nigrum, 394; tuberosum, 32, 329
 Sorghum, *see* Andropogon sorghum
 Soursop, *see* Anona muricata
 Soy beans, Sclerotium on, 336
 SPENCE, E. R., *see* EWING, P. V., AND SPENCE, E. R.
 SPILLMAN, W. J., AND GOLDENWEISER, E. A., cited, 145, 146
 Sphingidæ, 19 ff.
 Spilanthes acmella, 393
 Spodoptera mauritia 27 ff., 326
 Spondias purpurea, 33
 Spotted cutworm, *see* Agrotis c-nigrum
 Spreng, *see* Antidesma bunius
 Squash, *see* Cucurbita maxima; Sclerotium on, 338
 Squashes, storage, 425, 433 ff.
 STANFORD, E. E., AND WOLF, F. A., cited, 393
 STANTON, A. T., *see* FRAZER, H., AND STANTON, A. T.
 Star scale, *see* Vinsonia stellifera
 Starch from cassava, 73
 STEENBOCK, H., *see* HART, E. B., STEENBOCK, H., AND HOPPERT C. A.
 Stenocranus agamopsyche, 31
 Stephanoderes tamarindi, 329
 STEPP, W., cited, 448
 STEVENS, F. L., AND SACKETT, W. G., cited, 393
 STEVENS, L. F., cited, 422
 Sthenias varius, 33
 Stizolobium niveum, 393
 Storage of some root crops and other perishable farm products, 423
 Stored product pests, 35
 Study of the normal variation in frequency of pulse, respiration, and temperature of the carabao, a, 283
 Sugar apple, *see* Anona squamosa
 Sugar cane, *see* Saccharum officinarum; breeding in the College of Agriculture, 211; moth borer, *see* Diatraea sp.
 Sugar, conditions affecting quantitative determination
 Sugar Palm, *see* Arenga pinnata
 Sugar technology, course in, 87
 Sweet potato, *see* Ipomoea batatas; breeding, 177; flower, 177; leaf spot, 254; pollination, 178; tubers, storage, 424, 432 ff.; weevil, *see* Cylas formicarius (?)
- T
- Tachardia minuta, 24
 Tagabang, *see* Corchorus olitorius
 Tamarind, *see* Tamarindus indica
 Tamarindus indica, 33, 329
 Tañgan-tañgan, *see* Castor oil plant
 Taño, *see* Chrysanthemum coronarium
 Tapioca plant, *see* Manihot utilissima
 Taro, *see* Colocasia esculentum
 TAUSSIG, F. W., cited, 145
 TAYLOR, HENRY C., cited, 145, 155; RUTH, notes on, 39
 Tectona grandis, 393
 Tectocoris lineola, 22
 Temnochilidæ, 35
 Tenancy on coconut holdings in the municipality of Looc, province of Romblon, 145
 Tenants, rent, 147; share, 147
 Tenebrioides mauritanicus, 35
 Tenebrionidæ, 26
 TEODORO, ANASTACIO, notes on, 261
 Termes luzonensis, 13
 Termitidæ, 13, 14, 18
 Tetraneura oryzae, 27
 Tettigoniella ferruginea, 31; viridis, 31; spectra, 27
 Theobroma cacao, 329
 Thosea cinereamarginata, 17; sinensis, 18, 25
 Thripidæ, 10, 19, 25
 THURLOW, L. W., *see* BRILL, H. C., AND THURLOW, L. W.
 Thysanoptera, 10, 19
 Thyrididæ, 12
 Tineidæ, 14, 16
 TIMIRIAZEFF, A. C., cited, 195
 Tingitidæ, 17, 26
 Tobacco, *see* Nicotiana tabacum; caterpillar, *see* Prodenia litura; stem borer, *see* Phthorimæa hilopa
 Tomato, *see* Lycopersicum esculentum
 Tomato, *see* Lycopersicum esculentum
 Tortoise-shell beetle, three spotted, *see* Metritona trivittata
 Toxoptera aurantii, 16, 33
 TRACY, S. M., cited, 424
 Transparent scale, *see* Aspidiotus destructor
 TRELEASE, SAM F., cited, 318; notes on, 125, 445; mentioned, 103; AND JURADO, M. C., 318; AND PAULINO, P., cited, 318
 Tribolium confusum, 35; ferrugineum, 35

Trigona biroi, 200
 Trilophidia annulata, 31
 Trinidad, plant diseases, 348
 Trogoctidæ, 35
 Tropaeolum lobbianum, 393; perigrinum, 393
 Tropidocephala saccharivorella, 31
 Trypetidæ, 15 ff., 324 ff.
 TUASON, DIONISIO, notes on, 353
 Tuba, *see* Saccharum officinarum
 TUBANGUI, MARCOS A., *see* SCHWARTZ, BENJAMIN, TUBANGUI, MARCOS A., AND FRANCISCO, SINTO A.
 TUFTS, P. W., cited, 207
 Tugui tubers, storage, 424, 431 ff.
 TURNER, HOWARD A., *see* GRAY, L. C., AND TURNER, HOWARD A.
 Turnip, *see* Brassica
 Two serious plant diseases new to the Philippines, 253
 Two years of sweet potato breeding, 177

U

Ubi, *see* Dioscorea alata; tubers, storage, 424, 430 ff.
 UNGER, L. J., *see* HESS, A. F., AND UNGER, L. J.
 UNITE, JUAN O., comparative tests of rice seeds from the principal and poorest culms in individual plants, 243; mentioned, 189, 217
 University of the Philippines, 481
 URETA, ELIGIO C., abstract by, 350; 443
 Urinary calculi, 451
 Uromyces appendicalatus, 349

V

VAN DER LINDEN, T., cited, 59
 VAN KAMPEN, G. B., cited, 45, 56
 VAN SOMEREN, J. E., *see* WANBURG, OTTO, AND VAN SOMEREN, J. E.
 Variation and correlation of characters among rice varieties with special reference to breeding, 93
 Variety test of cassava based on production, abstract, 255; of upland rice, abstract, 256
 Vegetables, Philippine, 113
 VENTERA, TRANQUILINO, notes on, 86, 127
 Verbena erocoides, 393
 Vespaluctuosa, 200
 VIBAR, TORIBIO N., cited, 316; notes on, 125; variation and correlation of characters among rice varieties with special reference to breeding, 93
 VIEULES, G., cited, 94
 Vigna sesquipedalis, 395; spp., 34, 329
 Vinsonia stellifera, 24
 VILLALUZ, MOISES, mentioned, 189
 VILLANUEVA, CRISPIN, mentioned, 217; LEON BAYOT, in memory, 173

VILLARAZA, MARIANO F., notes on, 262
 VILLAVECCHIA, VITTORIO, cited, 56
 VISTA, T. I., cited, 195
 Vitamines, 450, 452
 Vitis vinifera, 34
 VOIT, CARL, cited, 447

W

WANBURG, OTTO, UND VAN SOMEREN, J. E., cited, 93
 Watermelon, *see* Citrullus vulgaris
 WATT, SIR GEORGE, cited, 93
 Weather observations, 350; May to December, 1920, 263; January to May, 1921, 307; June to September, 1921, 356
 Weevil, banana, *see* Cosmopolites sordidus; bean, *see* Acanthoscelides obtectus; coffee bean, *see* Araëocerus fasciculatus; cowpea, *see* Bruchus chinensis; granary, *see* Calandra granaria; rice, *see* Calandra oryzae
 WELLES, COLIN G., plant diseases found at Trinidad in December, 1921, 348; two serious plant diseases new to the Philippines, 253; AND ROLDAN, EMILIANO F., solanaceous wilt in the Philippine Islands, 393
 WEST, AUGUSTUS P., AND BROWN, WILLIAM H., cited, 55
 WESTLEY, —, mentioned, 214
 WESTON, JR., W. H., notes on, 37
 What is agricultural engineering, 130
 Wilt, solanaceous, in the Philippines, 393
 WOLF, F. A., *see* GARNER, W. W., WOLF, F. A., AND MOSS, E. G.; *see* also STANFORD, E. E., AND WOLF, F. A.
 Women students at the College of Agriculture, 361
 WOODWORTH, H. E., a host index of insects injurious to Philippine crops: I, 9; II, 321; mentioned, 207, 376; notes on, 38

X

Xyleborus perforans, 30, 324
 Xyliplocus capucinus, 24
 Xylotrupes gideon, 321

Y

YAP, SEVERO G., the effect of season upon the culture of roselle, abstract, 405
 Yatab, 304
 Yautia suckers, 425; storage, 431 ff.
 Year's enrollment, the, 89
 YULE, EMMA S., 37; notes on, 125, 175, 261; rice growing portrayed in Chinese art, 131; the Chinese imperial spring plowing, 407; women students at the College of Agriculture. Why not? 361

Z

Zanahoria, *see* Daucus carota

The Philippine Agriculturist

August, 1921

Editorials

1

A Host Index of Insects Injurious to
Philippine Crops

H. E. Woodworth 9

College and Alumni Notes

37

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
FORMAN T. MCLEAN, PH. D. *Professor of Plant Physiology*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The *Philippine Agriculturist* is published monthly, except in April and May by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.

23
ENTOM

The Philippine Agriculturist

September, 1921

Chemistry Number

Editorials		41
A Biological Study of Copra Meal	<i>Antonio Derecho</i>	45
The Chemical Composition of Copra Meal	<i>Elias M. Caray</i>	55
Investigation of Conditions Affecting the Determination of Reducing Sugars by Fehling Solution	<i>F. A. Quisumbing and A. W. Thomas</i>	69
Starch from Cassava	<i>Manuel L. Roxas and Ramon V. Manio</i>	73
Industrial Alcohol from Cassava	<i>Manuel L. Roxas and Ramon V. Manio</i>	75
Chemistry Notes		85

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
FORMAN T. MCLEAN, PH. D. *Professor of Plant Physiology*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

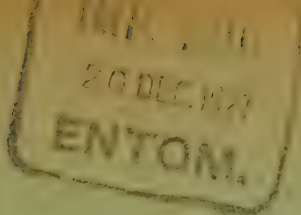
Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.



The Philippine Agriculturist

October, 1921

Editorials 89

Variation and Correlation of Characters
Among Rice Varieties with Special
Reference to Breeding *Tortbio Vibar* 93

Instruction and Investigation in Plant
Breeding in the Philippines *Nemesio B. Mendiola* 105

Philippine Contributions on Agricul-
tural, Biological and Industrial
Chemistry *Francisco A. Quisumbing* 113

College and Alumni Notes 125

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

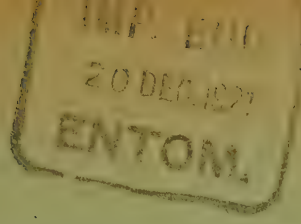
Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.



The Philippine Agriculturist

October, 1921

Editorials

89

**Variation and Correlation of Characters
Among Rice Varieties with Special
Reference to Breeding**

Toribio Vibar **93**

**Instruction and Investigation in Plant
Breeding in the Philippines**

Nemesio B. Mendiola **105**

**Philippine Contributions on Agricul-
tural, Biological and Industrial
Chemistry**

Francisco A. Quisumbing **113**

College and Alumni Notes

125

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The *Philippine Agriculturist* is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, *Philippine Agriculturist*, Los Baños College, Laguna. All remittances should be made payable to The *Philippine Agriculturist*.

Communications for the editors should be addressed to the Editors, *Philippine Agriculturist*, Los Baños College, Laguna.

The Philippine Agriculturist

December, 1921

Plant Breeding Number

Two Years of Sweet Potato Breeding	<i>Nemesio B. Mendiola</i>	177
The Pollination of Coconut	<i>Victor C. Aldaba</i>	195
Sugar Cane Breeding in the College of Agriculture	<i>Nemesio B. Mendiola</i>	211
Comparative Tests of Rice Seeds from the Principal and Poorest Culms in Individual Plants	<i>Juan O. Unite</i>	243
Two Serious Plant Diseases New to the Philippines	<i>Colin G. Welles</i>	253
Abstracts		255
College and Alumni Notes		259
Weather Observations		263

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. RÓXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.

The Philippine Agriculturist

January, 1922

Editorials	271
The Cultivation of Abaca and Preparation of its Fiber in Davao	<i>Vicente C. Aldaba</i> 273
A Study of the Normal Variation in Frequency of Pulse, Respiration, and Temperature of the Carabao	<i>James B. Ashcraft</i> 283
Pedigree Selection with Native Yellow Flint Corn	<i>Lorenzo Goco</i> 289
Effect on Banana Fruit of Premature Inflorescence	<i>Nemesio B. Mendiola</i> 299
Abstracts	303
Weather Observations	307

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSE J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

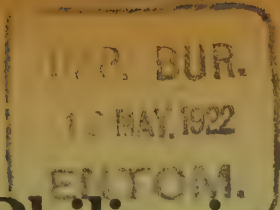
Assistant Business Manager

JOSE M. CAPINPIN, B. Agr. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.



The Philippine Agriculturist

February, 1922

Mineral Salt Requirement of Rice	<i>Rafael B. Espino</i>	313
A Host Index of Insects Injurious to Philippine Crops: II	<i>H. E. Woodworth</i>	321
Sclerotium Disease of Rice	<i>E. de Braganca Pereira</i>	331
Hog Cholera at the College of Agri- culture	<i>B. M. Gonzalez</i>	347
Plant Diseases Found at Trinidad in December 1921	<i>Colin G. Welles</i>	348
Abstract		350
Note on Weather Observations	<i>Frank P. McWhorter</i>	350
College and Alumni Notes		353
Weather Observations		356

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The *Philippine Agriculturist* is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.

The Philippine Agriculturist

March, 1922

Editorial 361

Additions to Philippine and Ma-
layan Technical Bibliography *Charles Fuller Baker* 363

The Banana Weevil *Silverio M. Cendaña* 367

Effect of Time and Planting on
Growth and Yield of Lowland
Rice *Ambrosio P. Abesamis* 381

Solanaceous Wilt in the Philip-
pine Islands *Colin G. Welles and Emiliano F. Roldan* 393

Abstract 399

PUBLISHED BY
THE COLLEGE OF AGRICULTURE
OF THE
UNIVERSITY OF THE PHILIPPINES
LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.

The Philippine Agriculturist

April, 1922

The Chinese Imperial Spring Plowing	<i>Emma S. Yule</i>	407
Banana Stem and Fruit Rot	<i>Julian A. Agati</i>	411
Storage of Some Root Crops and Other Perishable Farm Prod- ucts	<i>Domingo S. Baybay</i>	423
Note on "Effect on Banana Fruit of Premature Appearance of the Inflorescence"	<i>Frank P. McWhorter</i>	441
Abstracts		443
College and Alumni Notes		445

PUBLISHED BY

THE COLLEGE OF AGRICULTURE

OF THE

UNIVERSITY OF THE PHILIPPINES

LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. D. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. AGR. *Assistant in Agronomy*

The Philippine Agriculturist is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, Philippine Agriculturist, Los Baños College, Laguna. All remittances should be made payable to The Philippine Agriculturist.

Communications for the editors should be addressed to the Editors, Philippine Agriculturist, Los Baños College, Laguna.

Volume X

Number 10

IMP. BUR.

- 8 AUG 1922

ENTOM.

The Philippine Agriculturist

May, 1922

The Modern Conception of Nutrition and Some of Our food Problems	<i>Manuel L. Roxas</i>	447
The Control of Soil Moisture by Means of Auto-Irrigators	<i>Fernando de Peralta</i>	467
Announcement		479
Administrative Officers		481
General Information		485
Regulations Relative to Curricula		494
Subjects of the Curricula		497

PUBLISHED BY

THE COLLEGE OF AGRICULTURE

OF THE

UNIVERSITY OF THE PHILIPPINES

LOS BAÑOS, LAGUNA

The Philippine Agriculturist

Editors

EVERETT D. HESTER, A. B. *Professor of Economics*
EMMA S. YULE, B. Di. *Associate Professor of English*

Business Manager

NEMESIO B. MENDIOLA, PH. D. *Associate Professor of Agronomy*

Board of Control

CHARLES FULLER BAKER, M. S. *Dean, College of Agriculture*
MANUEL L. ROXAS, PH. D. *Professor of Chemistry*
H. E. WOODWORTH, B. S. *Professor of Entomology*
JOSÉ J. MIRASOL, PH. D. *Assistant Professor of Agronomy*

Assistant Business Manager

JOSÉ M. CAPINPIN, B. Agr. *Assistant in Agronomy*

The *Philippine Agriculturist* is published monthly, except in April and May, by the College of Agriculture, University of the Philippines, Los Baños, Laguna. The subscription price is ₱4.00 per year in the Philippine Islands and \$2.50 elsewhere; the price of single copies, 40 centavos in the Philippine Islands and 25 cents elsewhere. Orders for service of less than half-year will be charged at the single-copy rate.

Business correspondence should be addressed to the Business Manager, *Philippine Agriculturist*, Los Baños College, Laguna. All remittances should be made payable to The *Philippine Agriculturist*.

Communications for the editors should be addressed to the Editors, *Philippine Agriculturist*, Los Baños College, Laguna.

